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THE CLASSICS THAT EDUCATE US.

By PAUL R. SHIPMAN.

I HAVE great respect for the classics, and would do anything within reason to spread the knowledge of them; but a preliminary question must first be answered. *What* the classics are is not a matter of dispute, all agreeing that they are literary masterpieces, the study of which serves above all other studies to refine and liberalize the mind. But *where* are they? As to this, opinions differ.

"The Greeks, madam," replied John Randolph, when Mrs. Jellyby asked him to contribute aid to that suffering people—"the Greeks are at your door." And some people think the classics are in the same vicinity; dwelling, that is to say, in our mother-tongue in the sense in which the needy are at hand—not exclusively, but in such wise as to deserve our first attention. The President of Harvard College is one of these people. "I may avow," says President Eliot, "as the result of my reading and observation in the matter of education, that I recognize but one mental acquisition as an essential part of the education of a lady or a gentleman—namely, an accurate and refined use of the mother-tongue. Greek, Latin, French, German, mathematics, natural and physical science, metaphysics, history, and æsthetics are all profitable and delightful, both as training and as acquisitions, to him who studies them with intelligence and love, but not one of them has the least claim to be called an acquisition essential to a liberal education, or an essential part of a sound training." He adds: "The fruit of liberal education is not learning, but the capacity and desire to learn; not knowledge but power." This is explicit enough. For my own part, I agree to it.

But some people do not—affirming, contrariwise, that a knowledge of Latin and Greek is essential to a liberal education. Among these

people is Mr. W. T. Harris, a distinguished educator of St. Louis, and one of the most acceptable of the lecturers, if not the most acceptable, in Mr. Alcott's Summer School of Philosophy at Concord. "Mr. Harris," writes one describing this New England reproduction of the Academy of Plato, "is the star of the school, it would appear, since every one agrees that he is extremely interesting to hear, though few pretend to understand him, and those who do find their profession treated with incredulity." I confess myself a little surprised to learn that he proves unintelligible to any of the men and maidens of the new Academy, especially the maidens, for it is an article of faith in the "provinces" that the average maiden of New England, whatever may be the limitations of her father and big brothers, can understand anything, from the calculus of quaternions to the metaphysics of transcendentalism. Rufus Choate, it is told, once met Jeremiah Mason, with a daughter on each arm, returning from a lecture of Emerson's. "Well, Mr. Mason," said Choate, "you have been to hear Mr. Emerson!" "Yes!" sighed the venerable jurist. "And did you understand him?" continued Choate. "No," he replied, arching his eyebrows, and dropping a glance on either damsel, "but my *daughters* did!" I sincerely hope that the average maiden of New England has suffered no decline in these latter days. And yet a horrible suspicion intrudes itself. Can it be that much Greek has made her soft at last? However this may be, it can hardly excite surprise that Mr. Harris, teaching in the grove of Alcott, as Plato taught in that of Academus, and teaching, it would seem, with quite as many bees in his bonnet, if not on his lips, differs with President Eliot as to the special whereabout of the classics, or, what comes to the same thing, the essential part of a liberal education. It is not to be expected that one who comes forward to revive the Academy would go back on the Greeks. Yet he is none the less entitled to a fair hearing.

"The settlement of this old dispute," Mr. Harris says in a recent lecture, "lies involved in the question, What are insight-giving studies?" And the general principle that determines what are insight-giving studies, he insists, is this: "They must be of such a character that they lead the individual out of his immediate and familiar surroundings, and cause him to breathe the atmosphere and become familiar with the accessory conditions of an earlier historical stage of the people from whom he derives his culture and forms of civilization." This general principle he afterward compresses into the following paradox: "Self-alienation is necessary to self-knowledge." Under this principle he in conclusion thus sums up his position concerning the classics: "Not only for English-speaking nations, but for all modern Europeans, for the reason that they have derived their culture from Greece and Rome, the special culture-studies are Latin and Greek. The embryology of modern civilization is to be found in the literature and institutions of these wonderful peoples." "Mathematics," he de-

clares in the course of the lecture, "as the science of the general relations of time and space, the conditions under which existence in nature is possible, has the same relation to the insight of man into the physical world that classic study has to his insight into the world of institutions." These extracts, if I mistake not, fairly represent Mr. Harris's argument. Seeing that he is a very able and accomplished man, I take it for granted that his argument, as it is the last that has been delivered, is the best that can be made.

What Mr. Harris says of mathematics appears to me in itself to reduce his conclusion to something inconsistent with reason; not that he claims too much for mathematics in the sphere of physics, but that, in claiming as much for Latin and Greek outside of that sphere, he puts a contingent manifestation of mind on a level with the laws of mental processes, coördinating an artificial product with a formal science, two things of wholly different orders, and making the former a key to life as the latter is a key to nature. This at least betrays confusion of thought. If what Mr. Harris wants is a study that has the same relation to "the world of institutions" that mathematics has to "the physical world," he should take not Latin and Greek but logic, a science of the same order as mathematics, and dealing with thought precisely as mathematics deals with quantity. If he does not want a study of this kind, he should not represent what he does want as being such a study, and commend it on the strength of this fallacious representation. Latin and Greek certainly do not form such a study.

But "self-alienation is necessary to self-knowledge," says Mr. Harris; and the study of Latin and Greek, he maintains, is the surest way to bring about "self-alienation," which we may presume to have been the notion passing in the mind of Festus when he made that famous exclamation in the hall of audience at Cæsarea: "Paul thou art beside thyself; much learning doth make thee mad." And, truly, if a man has made up his mind to inflict "self-alienation" on himself, Latin and Greek will answer the purpose; but, before he drains the fatal cup, he should find out, if possible, exactly what he will make by it. A wise man considers the article before he decides to pay the price. Mr. Harris concedes that the "higher abstract elements" of the ancient civilizations can be reached through translation, but not, or at any rate not adequately, he says, the "earlier stages of growth—those of feeling and phantasy." These, as he contends, translation loses "in a large measure"; so that how the Greeks and Latins felt, and what they fancied, can be adequately seized only by "learning to think in their idioms, and to give our thoughts their forms and words." Here we have the article, with the price marked on it: a "large measure" of the "feelings and phantasies" of the Greeks and Latins, in return for learning to think in their idioms. Is not the price a little steep, considering the flatness of the article? Admitting that a full knowledge of the "feelings and phantasies" in question can not be got by translation,

and can be got by "self-alienation," is not "self-alienation," as defined by Mr. Harris, too much to pay for it? Whatever the value of the knowledge, who, for the sake of getting it, could reasonably spend the best years of his life, or any of his years, in trying to make himself a Roman and a Greek rolled into one? And who of all this breathing world has tried it and succeeded? Has Mr. Harris? Can he himself think in the idioms of the Greeks and Latins, and give his thoughts their forms and words? I do him the credit to believe that he can not, but, if he could, the fact, I venture to suggest, would rather explain his alleged obscurity in the use of his own language than prove the necessity of mastering theirs; for it would be only natural that one who had carried "self-alienation" to this length should not be at home in his vernacular. He who travels out of himself so far will be apt never to get back again. In his case there would be no "Return of the Native." The "grand tour" would *finish* his education, no doubt, in the primary sense of the word. A kind of culture such a man might have, but it would not be liberal culture, to which, on the contrary, it would bear scarcely more resemblance than a Strasburg goose to the noble fowl apostrophized in the lines of Bryant. It would be an intellectual monstrosity. But "self-alienation" to this degree is happily out of the question. For all, except one in a myriad, it is simply impossible. This explodes the argument as put by Mr. Harris. If the study of Latin and Greek to the only pitch adequate is not a possibility, what is the use of studying them at all? Mr. Harris can have no answer, unless he recasts his argument, which he can hardly do, I think, to any better purpose.

For, is there a modicum of truth in his paradox? In what sense is "self-alienation" in any degree "necessary to self-knowledge," or, which is more to the purpose, self-culture, because the end of liberal education, as President Eliot says, is "not knowledge but power"? The true condition of culture is self-activity, and how far is this determined by that "self-alienation" which consists in projecting one's self into the idioms of a dead language? Nearly as far, perhaps, as would be the corporal activity of one who should take a "header" into the Dead Sea, and essay to cleave its dense waves, beating against his breast like sledge-hammers. A dead language is the Dead Sea of thought, if it may not be more aptly likened to the Sea of Tranquillity in the moon. We think in our mother-tongue only, through which only, therefore, our self-activity is determined, and by which only, for that reason, we cultivate our minds. Our mother-tongue is the sole medium of our mental development. Only by means of it can we even *self-alienate* ourselves. A dead language is a counteractive instrumentality; for which reason we can no more develop our minds freely in Greek or Latin than we can develop our muscles in "twisted gyves." Studying to think in a dead language is shackling the mind, instead of liberating it, and must lead not to a free but to an arrested

development. "Self-alienation," if I may be allowed to aphorize a little, too, is self-repression, which will stunt the developing intellect, though it may stimulate the developed one. Culture, be it observed, is not capacity but the growth of capacity, and that which might energize the one would paralyze the other, the full-formed organ deriving strength from what may deaden the rudiment. The study of foreign languages, in place of being the means of culture, is simply a means of knowledge, and the study of the dead languages is not a necessary or convenient means to that. Our mother-tongue alone, as the instrument of our thinking, is the instrument of our culture. It is hence the thing of all things that we should master first and master thoroughly. In this philosophy and common sense are at one.

But the obvious way to master our mother-tongue is to study *that*, and not the mother-tongue of somebody else—to study it in its own masterpieces, not excluding indeed its adopted ones, whether from the Greek or Latin or any other original, but studying these in its own idioms, forms, and words, not in theirs. If there is to be any *alienation* in the matter, let the Greeks and Latins suffer it; they are dead, and it will not hurt them. Us it will hurt of necessity, since it will hinder our mastery of the tongue whereby we think, and by which, consequently, we master our faculties. Here, doubtless, I shall be confronted with the necessity of "self-alienation" as a means of knowing our mother-tongue itself, and not unlikely be reminded of Goethe's aphorism, of which Mr. Harris's is a tolerable equivalent: "He who is acquainted with no foreign tongue knows nothing of his own." To this there are two answers: it is irrational, and imposing facts contradict it. Strictly speaking, the converse of the proposition is true: he who knows nothing of his own tongue knows nothing of any other, for it is through his own that he becomes acquainted with another. The literal aphorism is literally preposterous. Assuming that it means in reality, what is the least admissible meaning, that he who is acquainted with no foreign tongue is not a master of his own, it is still irrational. What constitutes the mastery of a tongue? The "accurate and refined use" of it. And what, by common consent, is the criterion of this use? The established practice of the best writers and speakers of the tongue. Then how can the use be acquired better than by the study of these writers and speakers? Nay, how otherwise can it be acquired at all? And why is the study of any other tongue necessary? We can conform to the use of the best writers and speakers only by studying their works, and, when we have done this effectually, we have nothing else to do; the habit of conformity is established—the use is acquired. One does not learn to employ the brush by handling the chisel, or to shoot a rifle by throwing a boomerang; yet he could do either about as well as learn to use his native tongue by studying a foreign one, from which the incidental gain to his vocabulary would be offset by the loss to his syntax, while the linguistic learning that he

might gather would be likely to cramp his expression as much as it enlarged his knowledge, leaving him, so far as the use of his own tongue is concerned, where he started, if not considerably behind that point. On the other hand, the study of his own tongue in its masterpieces would enrich his vocabulary, without corrupting his syntax, and perfect his expression, as well as enlarge his knowledge. In short, the study of it would make him a master of it. Respecting the descent of the tongue, as respecting the "embryology of modern civilization," he has no call to trouble himself till he has achieved this mastery, if ever. The one belongs to the philosophy of language, as the other to the philosophy of history. Neither has anything special to do with the use of English, which either would help him to master not less possibly and surely not much more than ontology or ontogeny or any other recondite study, that he may find it profitable or agreeable to pursue after (but not before) he has equipped himself for anything and everything by mastering his faculties, through the mastery of his native tongue. If for this, however, the study of the tongue in its sources were essential, he would have to go back not to Latin and Greek, which have only multiplied its words and modified some of its forms, but to Anglo-Saxon and the cognate languages, whence come the bulk of its working vocabulary and all its grammatical principles; but this study, as I have intimated, is not essential to culture. A scientific knowledge of our mother-tongue is no more essential to the accurate and refined use of it than a knowledge of anatomy is essential to the graceful and effective use of our limbs; for what Bacon says of commonwealths and virtue is far more true of linguistics and culture—they nourish culture grown, but do not much mend the seeds. If I had my way in the halls of education, I would not only dismiss Latin and Greek, but send off packing along with them the historical and comparative study of English itself, and, bringing to the front, say, mathematics, chemistry, physiology, and philosophy, natural, moral, and mental, put the whole training squad under the immediate command of Captain English—not the fossil infant of the Cædmon age, but the living man of the nineteenth century, with whom we all have a speaking acquaintance at least. Glossology is important in its place, but it has no proper place in a scheme of education. Putting English glossology into such a scheme, after putting out the dead languages, has the appearance of giving a sop to the classical Cerberus—a weak concession to the enemy. Erudition, it should never be forgotten, is not education, nor the means to it; on the contrary, education is the means to erudition, as to every other spoil of intellect. And education, it can not be too often repeated, is essentially and preeminently the mastery of one's own language; for which the masterpieces of the language are not merely indispensable but enough. Sufficient for the mastery of English is the study thereof. The aphorism of Goethe is as false in spirit as it is absurd in letter.

Small wonder that imposing facts contradict it. The Greeks themselves were acquainted with no foreign tongue. Did they know nothing of their own? They declined to seek culture in "self-alienation," as they might have done, by studying to think in the idioms and to give their thoughts the forms and words of the Pelasgians, Egyptians, Phœnicians, or Persians, although some of them, it is true, when already cultivated, picked up what they thought worth taking among the intellectual possessions of these people, as was sensible; but their own language was the exclusive instrument of their culture, as the study of it was their exclusive means of knowing it. The "special-culture study" of the Greeks was their mother-tongue; and the method that sufficed for them—which trained Homer, Socrates, Plato, Thucydides, Demosthenes—will suffice for us. It has sufficed for us. Shakespeare, the greatest master of expression that the race has produced, knew no tongue but his own; and from the solar splendor of this supreme instance the argument, as no English scholar need be told, shades downward through one radiant name after another in the firmament of our literature. And the method is vindicated by not less significant products in other tongues, as witness, notably, the Icelandic "Njála," a biographical work at once of surpassing excellence in style and of purely native culture. Witness, furthermore, the Chinese, who, though the Chinese language consists of upward of forty thousand characters, and is in other respects amazingly cumbrous, have made of their vernacular, by dint of studying it exclusively, and in spite of the pernicious extreme to which they have carried exclusiveness in other directions, an instrument of culture that turns out, in the department of affairs at all events, some of the most highly developed intellects of the time. Sir Frederick Bruce, who represented the British Government at Washington after having represented it at Peking, avowed when in this country that the ablest statesman he had ever met was a mandarin. The Chinese, by the way, make dwarf trees, of which they are very proud, by cutting off the tap-roots, and resting the mutilated ends against stones, thereby striking at the seat of vigorous growth; but, taking no pride in dwarf intellects, their plan of education goes on the opposite principle—the tap-root of the mother-tongue being carefully preserved, never cramped, and continually nourished, the upshot of which is that, while they keep dwarfs in their flower-pots, they have giants in their councils. The facts of which these are examples admit of no answer. They make short work of Goethe's aphorism, and its pretty offspring, the paradox of Harris, breaking down their letter, cutting up their spirit, and sweeping them away to a common limbo. Nor do they leave any solid ground in a course of English for the Anglo-Saxon and its Teutonic congeners. What knew Demosthenes, for instance, of the lineage and affinities of Greek? Before they were fixed he was dead, and, for that matter, Greek itself was dying, although Plato, Aristotle, and some others, to

be sure, had touched upon certain aspects of the subject. And what did Shakespeare know of the philology of English? It is a common saying that Shakespeare knew everything, and indeed he knew the human mind so well that he easily divined its possibilities, not simply beyond his own positive knowledge, but beyond the positive attainments of the race, the head-light of his genius having thrown a blaze along the track of human progress to the other side of stations that the imperial train has been generations in approaching and which it has not yet passed; but intuition, though divine, can not do much with the hidden roots of a language, which call for the grub-axe of the grammarian rather than for the scimetar of the poet, and it is not too much to say that the man who knew everything knew next to nothing of philology. Other instances need not be adduced. To back these would be to gild refined gold.

Not only is our mother-tongue, then, the instrument of our culture, but the way to master it is to study it, in lieu of any foreign tongue, living or dead. For English-speaking people the "special-culture study" is not Latin and Greek or either, but English. The mother-tongue, if I may recur to the botanical figure, is the tap-root of the tree of mind, whereof no other tongue can be more than a rootlet. Neglect it, and you dwarf the intellect; cherish it, and the intellect shoots up into full stature. Our mother-tongue is the source of our mental growth. The time-worn notion opposed to this not only is false, but its falsity is susceptible of demonstration in the strict sense of the term.

A curious question remains: How is it that a notion so contrary to reason and experience has dominated the world for century after century? Of course, there is a cause for this effect. What is it? At the bottom or near the bottom of our mental nature lies a propensity which, as related to the intellect, is called *imitativeness*, and, as related to the will, may be called *sequaciousness*. It is, we all have reason to know, an active agent in the formation of whatever we become—the shuttle, if I may so call it, of the loom of man, shooting its double thread back and forth through the warp of his existence. If some order of superior beings, capable by hypothesis of anything, should take it into their heads to strike a medal expressive in a general way of their sense of human character, and drop it from the clouds, it would probably bear the image of a monkey on the obverse face, and on the reverse that of a sheep; and we should all have to acknowledge, with such grace as we could muster, the palpable hit of our celestial satirists. Certain it is that, when we see a thing done by somebody else in the line of our aspirations, we incline to do it ourselves, and to keep on doing it, until some other body, of higher skill or greater force, does some other thing in the same line. The flock follows the first sheep that jumps, and jumps to his jumps, till he jumps no more, or is overjumped by another. This is the general movement, subject

to diversions, checks, stops, reversals, renewals—all, indeed, proceeding according to the self-same tendency as the general movement, but out of which, together with that movement, comes in the long run true advancement—the cloth of gold of civilization; for it would be a grave mistake, as I have implied, to suppose that this propensity is not of capital importance to the development of man. Without imitativeness, the first and most fruitful years of life would be a blank, to say nothing of the loss to every later year; and without sequaciousness society would run to anarchy, and leap into ruin. The bell-wether principle, it must be admitted, is a large factor in human progress; but, like every other factor, it may be taken too often, making the product not what it should be.

And this undoubtedly is what has happened in the case of education. In the infancy of our tongue, when the learning of the past was locked up in Greek and Latin, and the key to these languages, as well as the care of education, was in the hands of ecclesiastics, the study of the ancient classics became in some sort a necessity, the teachers being unable or unwilling to move in any other direction, and the learners having no choice but to follow. The jump of the ecclesiastical bell-wether drew on the herd, which, having once got under way, has kept on jumping in the same path, and is jumping in it now, when our tongue has grown up into a rich and glorious maturity, when the learning of the past not only has been transfused into it but is a drop in the ocean of its own acquisitions, and when the care of education, in common with other vital interests, is in the hands of the people. For this egregious persistence, however, the propensity I have mentioned is not alone responsible. Many things have coöperated with it. The dead languages, for one thing, have been put on guard at the gate of the professions, obstructing the admission of all to whom they were unknown; and, in case that obstruction fell short of exclusion, spreading the tables inside with their scraps, which haply might cause the bold intruder to repent that he had staid away from the feast of languages, or had not staid away from the feast of reason also. The flower of the youth of successive generations has thus been put under the classic screw. Then, again, many of the masterpieces of our language have been produced by men of classical training, and, pursuant to a familiar fallacy, the production is inferred to have come from the training because it came after it; whereas, it would be nearer the truth to infer that the production was not on account of the training, but in despite of it—the fruit of English training in the face of classical. Nevertheless, the classical has appropriated the credit. Something, likewise, must be imputed to the splendid renown of the Greeks and Latins, as also to the vague but strong attraction of the unknown, which, if we may believe a saying of the Latins themselves, is always thought to be magnificent. Finally, the victims of the dead languages, prompted by a natural pride, have for the most part kept their sacrifice to them-

selves, either saying nothing of it, or representing it, with half-unconscious guile, as the cream of intellectual sweetness. The inquisitive man who went into a side-show on the invitation of the showman, to see a wagon with one wheel, and saw a wheelbarrow, came out, Mr. Joe Miller avers, with such enthusiasm in his eyes and such laudation on his lips that the bystanders rushed pell-mell to view the marvel, from which they, too, returned in a state of misleading effusiveness. Something must be pardoned to the spirit of getting even; but more, I should own in candor, to an honest belief in the marvel extolled. Nothing in fact can be more natural than to exaggerate the value of that which has cost us dear, particularly when it is avouched to be invaluable by the practice of venerable institutions, and the authority of illustrious names, not to mention the prescription of centuries. Such, I think, are the chief things which have conspired with the bell-wether bias, to keep up the long, and senseless, and injurious pursuit of free development in the fetters of the ancients.

Be this explanation as it may, it is high time, and past high time, that the pursuit under these conditions were abandoned. It has been continued ages too long. If not abandoned, I am strongly tempted to predict that man, handicapped by the conditions, will be passed by woman, now almost abreast of him, and that before the end of the next century, unless woman gets handicapped herself, our great poets, novelists, historians, scientists, and philosophers—the leaders of thought and masters of style—will wear petticoats or Turkish trousers, and the lords of the creation, sent to the rear, will become hewers of words and drawers of grammar to the weaker vessels—their better-halves in very truth—the real architects of mind and acknowledged captains of civilization. Let the paragon of animals look to his supremacy. If he sticks to the dead languages, I see but one hope for him; and that is to persuade woman to accept for herself the chains that have been fastened on him, and which he has not had the wit or the manliness to break. This is his only hope, and the fortune of the tailless fox in Æsop admonishes him not to put his trust in this; although it must be acknowledged, in view of the course of study at such institutions as Smith, Vassar, Wellesley, and Girton, that the modern Reynard seems to be crying up his mutilated extremity with somewhat greater effect than his prototype of old was able to reach. But this, I hope, is more in appearance than in reality. When he of the fable opened his speech against tails, and proceeded with his ingenious reasoning, there were present in the assembly doubtless a few silly foxes who exchanged approving nods, hastily agreed that tails were inconvenient appendages, and perhaps went so far as to cut off their own on the spot, and range themselves ostentatiously under the countenance of the Great Tailless; but when the speech, clever yet extremely thin, was finished, and the settled sense of the meeting found a fitting voice, there was an end of all that nonsense. And

so will probably disappear the folly that breaks out in the curriculum of the institutions above mentioned. If not, and woman, in a vain wish to vindicate her equality with man by claiming the same weight that he foolishly carries, straps on her shoulders the dead languages, one thing is certain: she will never fulfill the proud prediction that I have ventured to make for her, but hereafter, as heretofore, will lag, instead of leading. However, I am not anxious that woman should lead. Nor yet would I have her lag. The best thing for both sexes, and for all rational interests, would be to drop the dead languages out of the scheme of education altogether, and stick to our mother-tongue until we are educated, when the study of foreign languages, dead and living, or any other outlying study that we like, will be in order. In acquiring the use of our faculties through the use of our vernacular, we acquire the key of universal knowledge, with which we may at pleasure unlock any door in that many-mansioned house. But, first, we should possess ourselves of this key. Education, like charity, begins at home. To-day, if we would have fruitful minds, we must cultivate our lingual birthright; to-morrow, if we please, to fresh woods and pastures new. Meantime, let Greek and Latin wait; and when Mr. Harris, or any other representative of those renowned tongues on the Stygian shore, asks us to contribute aid to the suffering classics, let our response be, in the spirit of Randolph's reply to Mrs. Jellyby: "The classics, sir, are at your door."

HYSTERIA AND DEMONISM.*

A STUDY IN MORBID PSYCHOLOGY.

By CHARLES RICHET.

II.

THE word anæsthesia signifies absence of sensibility. In order to comprehend the significance of this symptom, it is important to present a few summary notions relative to sensibility and the sense of touch. The skin of man, like that of all animals, is furnished with innumerable nerves which are sensitive to the most trifling exciting cause, so that, if we touch ever so lightly any point on the skin, the shock communicated to the sensitive nerves of that organ is transmitted to the brain, and provokes there a sensation and a perception. Several modes of sensibility in the skin have been distinguished. Thus by the tactual sensibility we perceive the contact of objects; but this is not all there is of the sense of touch, for at the same time with the contact we are able to feel the temperature and consistency of foreign

* Translated from the "Revue des Deux Mondes" by W. H. Larrabee.

objects. There is also a sensibility belonging to the muscles. When we make a motion—that of closing the hand, for example—we are not only aware of the effort we make to move the fingers and shut up the hand, but we also know that the movement is executed. Everything takes place as if the muscles were sensible, and each of the muscular contractions actually provokes a sensation. We should also distinguish between tactual and muscular sensibility and the sensibility to pain. When the skin is burned, or cut, or torn, the violent shock suffered by the nerves gives rise to a particular sensation, of which we have all had more or less experience, and which is called pain. The word is so clear and the thing so common that no other definition than the word itself is needed.

Some extremely curious observations may be made with patients who are wholly anæsthetic. We may prick them, pinch them, burn them, without their feeling the slightest pain. They do not perceive the contact of the objects that wound them. An experiment which always creates astonishment in persons who are not acquainted with medical practice is, to bandage the eyes of a patient, and scratch along her arm from place to place with a fine needle without her receiving the least intimation from her senses that she is wounded.

Anæsthesia is sometimes general and equally marked on the right and left sides, sometimes limited to a particular region of the body, as the forehead, the chest, or the forearm. Partial anæsthesia may occur even with patients who are only a little hysterical. If we seek to measure the sensibility of the different regions by pricking the skin lightly with a pin, we will often find a small zone of skin that is insensible. The Inquisitors of the sixteenth century had no other way of proceeding than this when they sought for the claw of the devil, only that, instead of touching the skin with pins, they made the executioner stick skewers of iron into all parts of the body. If the accused did not jump with pain at every implantation of the iron, they immediately declared that the devil had put his grip on her. The stigma of Satan was one of the most certain evidences of witchcraft. According to the most precise tokens of the exorcists, the devil's mark had the shape of a hare's paw.

Hysteric anæsthesia is often seated on only one side of the body; the affection in this form is called hemianæsthesia. The insensibility is so exactly limited to one side, that it is enough to go two or three millimetres to the right or left of the middle line of the body to establish the fact of the presence of sensibility or of its absence.

Although many researches have been made to discover the causes of this derangement of the nervous system, no satisfactory solution of the question has been reached yet. It seems to be proved that no material organic injury is connected with hysteria. The nerves of the affected side have the same appearance as the nerves of the healthy side; the marrow and the brains show no swelling, no hæmorrhage.

We have not in this case a disease in which any disorder in the structure of the organ can explain how its function is perverted. What further causes us to believe that it would be wrong to look for an organic hurt where there is only a dynamical perversion is, that hemianæsthesias, after having lasted for even four or five years, will sometimes disappear all at once without any appreciable cause of cure, and leave no traces. As we have said, hysteric patients have an uncertain and changing disposition. Their maladies are likewise capricious and fantastical, and will come on without known cause, and disappear in the same way. An insignificant emotion, hardly perceptible, is sometimes enough to dissipate a paralyis of several years' standing. I knew a case of this kind, in which an hysterical patient had been paralyzed for four years, so that she was not able to speak, or eat, or drink, and had to be fed by putting food into her mouth. One evening she spoke out all at once, and said she could eat without being helped. Her sudden cure was unexplainable. Analogous cases, when they take place in the Pyrenees, pass for supernatural and divine manifestations. We judge otherwise in Paris, and see in them only the irregular effects of a disease which is imperfectly understood, the singular and complex nature of which science has not yet unraveled.

Some very strange phenomena have been observed in hysterical patients. It appears to be proved that they can remain a very long time without taking food and without drinking ; at the same time, the secretions seem to be suspended, so that, under certain conditions not yet well determined, there takes place an almost complete cessation of the chemical operations of life, such as does not occur in other persons till the moment of death. "Nature," says M. Charcot, "seems to have a special provision for hysterical persons." The most surprising circumstance is that, although the attack be extremely violent and the alimentation most deficient and poor, the affected persons preserve their plumpness and the usual appearance of health. These facts are certainly not supernatural, though they have not been explained. It is right, then, to be on the guard against seeing in this prolonged abstinence, as they assumed to do in the case of Louise Lateau, a kind of miraculous divine protection. It is also necessary to beware against the simulations which many patients habitually attempt. It would be puzzling to say why they do this unless it be that they lie for the sake of lying, for the mere pleasure of propagating an error, even when that error is not to their profit. Some of the so-called demoniacs in former centuries indulged this curious fancy of making believe that they lived without food. Wier, one of the few persons who ventured to defend good sense against the universal folly of his age, tells how, in 1574, he exposed the tricks of a little beggar, who was probably hysterical, named Barbara, who made herself pass for a prodigy, and pretended not to eat or drink. He took the little mendicant home with him, watched her carefully with the aid of his wife and servant,

and so fully laid bare her deceptions that she was compelled to confess, not that she had been playing tricks, but that Wier had cured her.

Wier was not the only person who, even in the sixteenth century, protested against the abuse of the belief in the supernatural. Several educated physicians would not allow themselves to be blinded by the ruling prejudices, and referred nervous affections and convulsions to their true cause, hysteria, which they then called suffocation of the womb, instead of to the devil. It would, however, have been rash for them to deny the action of demons, and they were, therefore, reticent in expression, and used well-rounded phrases to disguise the boldness of their doctrine. "I have seen," says Houlier, "two daughters of a president of one of the Parliaments of France, subject to be taken with such fits of laughing that it was impossible to stop them, either by fright or by threats and scolding." "In suffocations of the womb," says a learned man of the sixteenth century, "incidents frequently occur which cause physicians of little experience to think that it is a case of enchantment or of something extraordinary and supernatural." They had also observed incidents of catalepsy and of burial alive in hysteria, but were very careful against ascribing them to the machinations of the devil.

The efforts of physicians to cure hysteric anæsthesia have only recently been attended with any success. A happy discovery, revealing a series of real but improbable facts, has led to the introduction of salutary modifications in the therapeutics of hysteria. Twenty-five years ago, M. Burq affirmed that the application to the skin of certain metals, as gold, silver, copper, or zinc, would cure neuralgias, headaches, and paralyses, but no one thought of making a scientific verification of his novel assertion. M. Burq passed out of notice, but continued to maintain that the treatment of nervous diseases with metals would lead to marvelous cures. He might, however, have preached in the desert till the end of his days, had it not occurred to M. Charcot to make a test of some of his experiments. He found that M. Burq's representations were correct, at least in part. Though the application of metals gives only moderate results in many nervous diseases, it is nevertheless true that in hysteria, and particularly in anæsthetic hysteria, it is attended with singular modifications in the symptoms. The application of pieces of gold or silver or other metal upon the insensible region is sufficient to produce a complete restoration of sensibility in the course of a few hours. Some patients are cured with gold, others with silver, others with zinc or copper. This process of treatment, which consists in the application of pieces of metal to the skin, is called metallotherapy.

Strange as these facts may appear, they have been verified too many times in France and other countries to permit us to call them in question. Additional researches have disclosed the manner in which

the metals act when they are applied to the skin. It is by the development of feeble electric currents in consequence of the contact of the metal with the moist and salty skin. The currents, although they have not enough intensity to be felt, are strong enough to modify the condition of the sensory nerves, cause anæsthesia to disappear, and reëstablish sensibility. Experiments made directly for that object have established the probability of this theory.

Magnets, which may be compared to very feeble electric currents, exert an action on the skin very like that of metals. The phenomena are very clear; but, instead of curing anæsthesia, magnets transfer it, causing it to disappear from one side and pass to the other side. If, for example, we apply a magnet to a patient insensible on the right side, at the end of half an hour the right side will have become sensible while the left side will have lost its sensibility, showing that the disease, instead of disappearing, has been carried over from one side to the other. Does not this facility with which the morbid spot may be moved exclude every hypothesis of a deep material lesion of the nervous centers? The facts of metallotherapy and magnetotherapy are of great interest in physiology as well as in clinics; but the exposition of them is very dry, and even this short glance at them may seem too long. I pass to the description of symptoms which we might call demoniacal, and which constitute the grand attack of hystero-epilepsy.

It would be hard to imagine a more terrible spectacle than that of one of these demoniac fits. The body pulsates with tremors and violent shocks. The muscles are contracted, so tense that we might believe them to be on the point of bursting. Great bounds, frightful cries and howlings, confused vociferations, indescribable contortions which we would not have supposed a human creature capable of making—such is the hideous picture which the hysterical patient presents when she is seized with an attack. After one has witnessed a scene of this character, he will be less astonished that the simple credulity of the men of the middle ages made them see in the phenomena the intervention of evil spirits, and that they supposed that only the devil could provoke such a furious exasperation of all the forces of the body.

As we study more closely the attacks of epileptic hysteria, we perceive that, in the face of this violent appearance of disorder, the disease has its regular, distinct periods. Nothing is at hazard. Every symptom, however unordered it may seem, appears in its turn with a surprising regularity, we might almost say punctuality. M. Charcot and his pupils* have shown that the demoniac fits embrace three well-characterized periods.

* Paul Richer, "Etude descriptive de la grande Attaque hystérique," 1879. The numerous drawings attached to this book, as well as the excellent photographs of MM. Regnard and Bourneville in their "Iconographie photographique de la Salpêtrière," give a very fair idea of the successive periods of the attack.

The first period is analogous to the attack of epilepsy proper. An abrupt loss of consciousness takes place. The patient falls to the floor; her muscles contract, stiffen; her face turns blue; the features are wrought into a horrible grimace; the arms bend; the hands clinch; in a few instants afterward the muscles quiver with convulsive tremblings, which at first grow more marked, then become weaker and weaker. At last, the muscles, exhausted by the long and violent strain, relax, and a deep, stupid sleep succeeds the convulsive spell.

This lasts only for a little while, and then begins the second period, which M. Charcot calls the period of *clownism*, because it recalls the curious attitudes and contortions of the clowns in the circus. At this stage the patient executes prodigious bounds; the body, bent into the arc of a circle, rests on the bed only by the head and feet; the face is disfigured, sometimes terribly so, and the twisted features give it a hideous expression; and at times the whole body will bound up, then fall heavily upon the bed. "The patient goes into a fury against herself," says M. P. Richer, describing one of the attacks; "she tries to scratch her face, to tear her hair, she utters pitiful cries, she hits her breast with her fist so hard that the attendants have to interpose a cushion; she springs at the persons who are around her, tries to bite them, and, if she can not get at them, tears everything within her reach, the bedclothes, her own clothes, bellows like a calf, strikes the bed with her head and her fists as if she could never get enough of it; she jumps up, throws her arms around, bends her legs up and kicks them out again, shakes her head back and forth uttering hoarse cries all the time, or, if she sits down, twists her body around from one side to the other, and keeps her arms moving."

Not less surprising than the violence of the attack is the ease with which it can be stopped. All the excess ceases at once on simply compressing the abdomen. The demoniac spell originates apparently in the ovary, for, on pressing the hand on the abdomen precisely at the point that answers to the ovary, the rage immediately ceases. The poor demoniac, restored to herself, casts an astonished look at the persons around her, as if she does not understand why they are there, for she was alone when she was seized, and has been unconscious since. She keeps her consciousness as long as the ovary is compressed, and is able to put the clothes in order, to talk, laugh, and enjoy herself cheerfully with her associates; but, if the compression is relaxed a little, the attack begins again with all its original force, to cease again if the ovary is compressed anew. By a coarse but intelligible comparison, the working of this pressure may be likened to the action of a faucet on the flow of water in a pipe. The flow ceases when the valve is turned off, to begin again as soon as it is turned on. The patients at the Salpêtrière understand the relation so well that, when one of them is attacked, the others straightway go to her bed and press on her abdomen, for several hours if it is necessary, till the

fit is over. The attack is marked by a complete absence of mind. The intellectual life is entirely suspended, but is resumed at the end of the fit, just as if nothing had taken place. If a remark has been begun and is interrupted, it is resumed on recovery at the point where it was interrupted.

We call these attacks indifferently demoniac fits or fits of hystero-epilepsy, because it was believed for a long time that demons were the real living agents that provoked the terrible morbid phenomena. The symptoms are the same, and it is only necessary to read the description of the demoniac attacks of the past to recognize their identity in all points with the hystero-epileptic fits of the present. Esprit de Bosrager, a Capuchin father, who was charged with the exorcising of the nuns of Louviers,* tells pertinently to this point: "On the day of Pentecost (1644), the same Dagon (this was the name of the devil that possessed Sister Marie du Saint Esprit) kept up for four good hours the greatest rebellion that could be imagined to prevent the girl from communicating, and during all this time he made her suffer extraordinary convulsions, threw her to the ground several times, forced her to make a hundred leaps, a hundred courses round the church, made her push at people, strike them, and throw them down .... Oh, what astonishing motions! what wonderful contortions! what furious rolling, sometimes into a ball, sometimes into horrible shapes! What numerous and rude convulsions in such delicate creatures, and with so frequent repetition and reënforcement! I should have to be persuaded very much, I assure you, before I would believe that sensible and judicious men would make all those convulsions pass for disease and all those wonderful movements and rollings for juggler's tricks. But what ought to convince every human mind as by a demonstration, what admits of no reply, and what all the famous doctors have acknowledged, is this: that it is quite impossible that convulsions, and such terrible ones, should come naturally by disease, should last so long, should return so frequently, should not leave lassitude after they had passed, and, finally, that they should not destroy the subject."

With all respect to the brave Capuchin, these spells of demonomania are a veritable disease. We are able to class the symptoms, distinguish the phases, the beginning, the middle, and the end, and we can affirm that the "wonderful rollings" of Sister Marie de Louviers belong to the second period of the hystero-epileptic fit.

The strange acrobatic attitudes which characterized the preceding phase are not observed in the third period. The limbs are no longer

* "La Piété Affligée"; or, "An Historical and Theological Discourse on the Possession of the Nuns called of St. Elizabeth at Louviers, by Esprit de Bosrager, Capuchin, Rouen, 1752," pp. 257. This is the work, otherwise very curious, which Michelet calls an immortal book in the annals of human folly. The author's style may be judged from the quotation.

cast about in every way, in obedience to the exaggerated excitation of the spinal marrow. Cerebral life, which has been suspended since the beginning of the attack, has returned, and consciousness has, at least partially, appeared again. Now, hallucinations of every kind arise, sometimes gay, sometimes sad, sometimes amorous, sometimes religious or ecstatic. Whenever any image rises in the mind, the movements of the limbs, the expression of the face, the general attitude of the body, respond at once to its character. These poses, these passional attitudes, have a vivacity, a vigor of expression, that can not be found anywhere else. The most skillful actor would never be competent to represent fear, menace, anger, with as much truthfulness and power as these poor hysterical girls, whose demeanor is influenced by the agitations of a raving and changeable delirium. One crosses her arms and raises her eyes to heaven in an attitude of religious admiration, as if she saw the clouds opening to show her the saints or God. Another talks in tender words to her little girl, from whom she has been separated for a long time. Another sees monstrous animals, lizards with red snouts and blood-shot eyes, or enormous bats, and her features express unspeakable horror. Generally there are two types of delirium, gay and melancholy, answering to corresponding forms of hallucination. The two frequently appear in combination, taking each other's place with marvelous rapidity. M. ——, says M. Paul Richer, "is with Ernest* at a pleasure-party in a restaurant near Paris, where the tables are set under trellises adorned with flowers and climbing plants. At the right is a negress surrounded with strong-armed black men who are tattooed, and entirely naked, who seize her by the hair and are about to scalp her. The blood runs in streams over the face of the unfortunate woman, who utters lamentable cries, and calls for help. On the left is a very different spectacle: Ernest has a throng of friends who accompany other young women. All the personages have no other clothing than a broad, red girdle, except Ernest, who wears a Spanish costume. They sit at the table, eat oysters, drink of a white wine, sing, and laugh." Each patient generally has a form of delirium peculiar to herself, so that the different attacks in the same subject always bear a resemblance to one another. The same personages appear, the same scenes are repeated in all the attacks. The order in which the hallucinations come on does not vary, and one who has witnessed a few attacks suffered by the same patient can always judge when the end of the fit is near from the nature of these hallucinations. With one, it is indicated by a flourish of military music; with another, by the noise of a railroad-train; with another, by the appearance of monstrous animals—vipers, crows, frogs, rats. The regularity of these mad deliria is indeed surprising. Listening to the vociferations, the howlings of the sufferers, it would seem as if chance alone directed the

* Names of young people have taken the place of the names of devils which the demoniacs formerly gave to the personages of their hallucinations.

horrible drama. In reality, all is foreordained, regulated. The tumult goes on with the mathematical precision of a well-adjusted clock.

Fantastic as the delirium of the patients during their attack may appear, it always has a cause and occasion. The hallucinations of a demoniac resemble the real episodes of her life, particularly the one which has had the most influence in the development of her malady. It is true, as we have already said, that the principal cause of hysteria is hereditary predisposition; still, an accident is needed, an exterior provocation for the first nervous crisis, some event which may be grave or light, to determine the outbreak of a malady which has been brooding for a long time. This event is often a fright, a violent emotion, some grief, a disillusion. Then, in the attacks of delirium, the things and persons that were the occasion of the emotion—fright, grief—reappear as hallucinations. This influence of what has happened in the past establishes an important difference between the delirium of the insane and that of persons suffering from hysteria. The visions of the insane, whatever they may be, generally have no immediate relation to anterior events, while the form of delirium in hysteria is nearly always determined by an incident which has formerly played an important part in the life of the patient. The visions of beasts and monsters are common to all delirium. They appear whenever a fever has deranged the cerebral functions, and are the generally recognized marks of alcoholic delirium.

The period of delirium which indicates the ending of the attack is sometimes quite short. More often it is prolonged for several hours, and not rarely it persists for some days. The cerebral functions have been deeply troubled, and they return very slowly to their normal condition. It is, however, hardly proper to use this expression to describe the intelligence of the hysterical patients as it is observed during the intervals between their fits. Intelligence, it is true, is not extinguished; the memory, the keystone of the intellectual arch, is preserved; but the other faculties are singularly perverted. We can gain a good idea of their condition by studying the manners and the conversation of the demoniacs in the Salpêtrière. They pass the day in continual laughing at things that have nothing laughable in them—at the servant-maid who passes by, for example, at a badly made bed, at a bird that perches near the window, at a badly fastened bonnet. The same causes will as readily provoke tears. Interminable conversations are always going on, recriminations, with indignation drowned in a flood of words. With all this is combined an unceasing movement which has no real object and can not be explained. The woman must put flowers on the bolster of her bed, a ribbon in her hair, she must decorate herself with gewgaws; and the busy carefulness in these little matters contrasts with the negligence and disorder of the general keeping; a patient whose hat is adorned with ribbons will go out barefooted into the court. Odd ideas prevail, and absurd antipa-

thies and sympathies. Hysterical patients demand, more than anything else, that other persons shall be occupied wholly with them, interested in their petty passions, that they take part in their likes and dislikes, that they admire their intelligence or their dress. They tell improbable stories, lie boldly, and are not disconcerted in the least when they are convicted of the lie. Deprived of all moral sense, they obey only because they have no alternative. No feeling of modesty or false shame restrains them; they tell their adventures to any one that comes, provided they are pleased with him, and will talk with men as freely as if they were of their own sex. Nothing embarrasses these female Diogeneses; they have an answer for everything, ask the most indiscreet questions, and tell the truth bluntly to every one. They are not deficient in self-love, and are indignant if one does not appear to be occupied with them. They never hold the same opinion long, and will pass from one sentiment to another with marvelous rapidity. No idea, no reasoning can hold them or persuade them. Their mind wanders from spot to spot without the power to settle itself, and it is as hard to fix the attention of an hysterical person upon a precise idea as it is by reasoning to induce a bird which is hopping about to stop and fix itself on a branch.

These unfortunate creatures are wholly deficient in good sense, and commit all manner of follies when left to themselves. It is necessary to be fully aware of this fact to understand why they are confined in an asylum for the insane; for when we question them, when we converse with them, we do not discover that total perversion of intelligence which we make out so easily with regard to most insane persons. We should have to see them in their working life, that is, in the midst of the exterior world, subjected to the exciting influences of every kind with which it abounds, to comprehend to what extravagances, not to use a stronger term, they will abandon themselves when no restraint hinders them. Sometimes, though rarely, they commit crimes. Most frequently they forge strings of fables to delude justice. One will cut herself with scissors, and pretend that some one has hurt her; another will feign pregnancy in order to make some one whom she hardly knows marry her; another is a kleptomaniac, and when she is in a shop steals everything within her reach, to accuse the first person that comes along of having committed the theft.

No description can be as valuable to convey an understanding of the nature of the disorders of the intelligence which hysteria causes as the simple story of a patient who has long been known at the Salpêtrière under the name of G——, and who is distinguished for the eccentricity of her disposition, as well as for the violence of the convulsions from which she suffers. G—— was born at Loudun on the 2d of January, 1843; was abandoned by her mother and put among the foundlings; after having passed her early years in an asylum, she was sent to the country. When fourteen years old she was courted by a young

man named Camille, but at the end of a year her affianced died of a brain-fever. She was shut up during the funeral, to prevent a scene, but got out of the window, ran to the cemetery, and wanted to throw herself into the grave. She was confined again, but went to the cemetery in the night, calling on her lover and wishing to dig up his body. She was afterward seized with a nervous fit, during which she appeared to be dead, and continued for about twenty-four hours in a complete lethargy. After two years more of residence in the asylum she seemed to have nearly recovered; then, at seventeen years of age, she took a situation as chambermaid at Poitiers. Her nervous attacks returned in a few weeks; she pretended to be pregnant, was believed, and was sent to the hospital to be confined. The deception was soon exposed, but her attacks had assumed a graver form; she was indomitable and rebellious to all discipline, and was sent to an insane asylum. While the physician was treating her with belladonna, she hid her daily doses of pills for ten days, and then took them all at once. They nearly killed her, but she recovered. She maimed her chest with a pair of scissors, and could not tell why she had done it. She ran away from the hospital and went to Paris, but was attacked again and sent back. She was transferred to the insane asylum at Toulouse, but escaped from there and returned to Paris, walking all the way, if her story is to be believed, dressed in the uniform of the asylum, sleeping in the woods, undressing herself to wash her linen, living on bread which she asked for at the farmhouses, and being three months on the road. She made up her mind, under the pressure of hunger, to beg in spite of her pride, saying that our Lord had asked for alms, and she could do what he had done. She was arrested at a railroad-station for tearing down the placards from the walls. She was taken back to the Salpêtrière, where she gave birth to a daughter in 1867. She escaped in 1870, and became an attendant in the hospital of St. Antoine, but gave way to violence in a dispute with a nun, and was discharged. She started to go to see her daughter in Burgundy after the armistice was signed, but was detained by the Prussians, returned to Paris, and went back to the Salpêtrière. At one time, having read in the papers the stories about the miraculous Louise Lateau, she desired to go to Belgium to visit "her sister." She was attacked with a fit on the way, and met with adventures in Brussels which prevented her making her visit. She finally returned to the Salpêtrière in 1877, and has been there ever since. She suffers from frequent demoniac attacks, but is generally quite docile and reasonable in a certain measure, ready to tell, to any one who will listen to it, her long and improbable history.*

The story of G—— will be read with more interest, if we are able to realize that two hundred and fifty years ago she would have been exorcised, or condemned as a witch and burned alive.

* For a more detailed narrative of the facts relative to G——, see the "Iconographie Photographique," part i., pp. 65, *et seq.*

THE CROSSING OF THE HUMAN RACES.*

By M. A. DE QUATREFAGES.

THE movement of expansion which followed the geographical discoveries of the fifteenth and sixteenth centuries has resulted in transporting to a host of points on the globe not only the European white but also the African negro, who was first carried away into slavery. Everywhere the two races have crossed with each other and with the natives of the place; and everywhere, in consequence of these unions of the two races, mixed populations have appeared, having in varied proportions the blood of the whites, the negroes, and the local races. This is a remarkable fact, which has engaged the attention of travelers, but which the founders of anthropology—Buffon, Blumenbach, and Prichard—and most of their successors, seem to have passed over. I have often pointed out this singular omission, and indicated the causes of it, the chief of which is that those writers were without the documents bearing on the subject which we possess now. I have also tried to fill the gap in the investigation, and, after having studied the phenomena from a general point of view, have shown, I believe, how the study of what has passed and of what is passing now throws light on the origin of populations which are often considered as of a pure race, and how an attentive study may enable us to discover traces of a crossing sometimes too ancient for the remembrance of it to survive, sometimes on the contrary recent enough to permit us to recover historical evidence of it. I have endeavored also to indicate what may be the consequences in the future of contemporary facts.

The conclusions to which this study has led me are in direct disagreement with those of some anthropologists, and in particular with the doctrines advanced by Dr. Nott, the Count de Gobineau, Dr. Perrier, Messrs. David, Turnham, Knox, etc. Without repeating the considerations I have already advanced concerning these differences of opinion, I will here point out what the differences are. Those who disagree with me affirm more or less explicitly that crossing between human races is of itself a cause of decline, and that, when two unequal races intermarry, the mixed population is fatally inferior to both. In the crossing of unequal races the superior is depressed, they say, without raising the inferior. The mixed race is more or less degraded physically, and is deprived of all disposition to work, of all moral force.

Most of the adversaries of crossing still maintain that the formation of a new race resulting from the union of two other races is really impossible. Populations originating thus can not be kept up, they

* Translated and abridged from the "Revue Scientifique."

say, except by the continued accession of new elements from pure races. If they are abandoned to themselves and left to form connections with each other, the mongrels will become infertile after a few generations, and the mixed race will disappear.

None of the eminent men with whom I regret to differ take any account of the influence of the action of the surroundings. I believe that the conditions of the surroundings play as important a part in the crossing of races as they do in other matters. They may sometimes favor, sometimes restrict, sometimes prevent, the establishment of a mixed race. This simple consideration accounts for many apparently contradictory facts. Etwick and Long have affirmed that in Jamaica the mulattoes hold out only because they are constantly recruited by the marriage of whites with negresses. But in San Domingo, in the Dominican Republic, there are, we may say, no whites, and the population consists of two thirds mulattoes and one third negroes. The numbers of the mulattoes are there well kept up by themselves without the introduction of fresh blood. In respect to fertility, different instances of crossing between individuals of the two same races may give different results, according to the place where they are effected. I believe it is unnecessary to insist and show that the physical and physiological faculties of children born of mixed unions ought to present analogous facts.

In my view the aggregation of physical conditions does not in itself alone constitute the environment. Social and moral conditions have an equal part in it. Here, again, it is easy to establish, in the results of crossings, differences which have no other cause than differences in these conditions. It is true that mongrels, born and grown up in the midst of the hatred of the inferior race and the contempt of the superior race, are liable to merit the reproaches which are commonly attached to them. On the other hand, if real marriages take place between the races, and their offspring are placed upon a footing of equality with the mass of the population, they are quite able to reach the general level, and sometimes to display superior qualities.

All of my studies on this question have brought me to the conclusion that the mixture of races has in the past had a great part in the constitution of a large number of actual populations. It is also clear to me that its part in the future will not be less considerable. The movement of expansion, to which I have just called attention, has not slackened since the days of Cortez and Pizarro, but has become more extended and general. The perfection of the means of communication has given it new activity. The people of mixed blood already constitute a considerable part of the population of certain states, and their number is large enough to entitle them to be taken notice of in the population of the whole world.

In using the word (*metis*) mongrel, or person of mixed race, I do not mean the fruit of union between individuals belonging simply to

distinct branches of a single great race. By that criterion all Europeans would be mongrels. That kind of crossing has been going on among us since the dawn of the present geological period. We may begin to trace it through prehistoric times; and from the birth of history, even in the legendary form, it appears preparing the way for the actual condition of things. This fact alone unequivocally condemns all the theories which ascribe a degrading influence to intermixture considered by itself.

I refer at present only to mixtures of the white with the negro and other colored races. M. d'Omalius d'Halloy, a Belgian scholar distinguished for his critical spirit, in the last edition of his "Anthropology," fixes the population of the globe at twelve hundred millions, and the number of mongrels from crossings of this kind at eighteen millions. Thus the latter already constitute one sixty-sixth of the whole human race.

The proportion becomes more considerable when we look at some of the states of South America, where the aggregation of circumstances has favored a mixture of races. Statistics already several years old show in Mexico, Guatemala, Colombia, the La Plata, and Brazil, a total of 16,040,100 inhabitants, of whom 3,333,000 are mongrels. The latter, then, form about one fifth of the population. This proportion, high as it is, is really too small, for, since the censuses from which the numbers were borrowed were taken, the mixture of races has increased; again, many persons of mixed blood have been counted as whites. In these countries any one who rises to an honorable position in society can call himself a white, and no one will refuse him the privilege. I know of a family in the best society of one of the Central American states, in which the negro and Indian blood are notably mixed. All of its members pretend to be pure whites and pass for such, and a person who should express any doubt on the subject would be very badly received.

The inhabitants of the province of São Paulo in Brazil are nearly all the mixed issue of marriages contracted by the Portuguese and by whites from the Azores with the native tribes, the Carijos and the Guayanazos.

These facts are significant. They become more so when we recollect how short a time has been necessary to produce such results. In South and Central America, and Mexico, the crossing has been going on on an extensive scale only since the conquest of Mexico and Peru, between 1519 and 1533. Less than three centuries and a half separate us from that epoch—and what are three centuries in the history of mankind? It is easy to believe that in three centuries more the mixture will be complete in that part of the New World.

Are the United States and Canada the theatre of ethnogenic phenomena analogous to those which we have just proved to exist in the countries south of them? The contrary is generally asserted. We

have only a few details concerning the mulattoes of the Southern States; and Dr. Nott has strangely contradicted himself in the few generalities he has written on this subject. Travelers sometimes speak of mongrels whom they have met on the confines of the Union or of Canada. But, on the whole, I know nothing precise on the result of the mixture of races in the vast region which extends from the frontiers of Mexico to beyond the Arctic Circle. The work of Mr. Daniel Wilson,* without entirely filling this gap, furnishes some really interesting statements bearing on this subject. It makes known some facts which, although they are presented in a little too general manner and without statistical details, are nevertheless of great value; and it states some others with more detail. Incidentally, it adds its testimony to the evidence which had already been gathered against the common errors which are daily repeated. By these features it merits the attention of anthropologists, and an analysis of some of its details is of interest.

[As Mr. Wilson's book is easily accessible to American readers, we will not repeat in detail the citations which M. de Quatrefages makes from it, but will only give a summary of the argument which he deduces from them.—EDITOR POPULAR SCIENCE MONTHLY.]

Mr. Wilson does not dwell at much length on the history of the mulattoes. Having mentioned the opinion of Dr. Nott, who believes that they are infertile, sickly, and destined to extinction, and having referred rapidly to a few local circumstances which seem to support this opinion, he concludes by saying that nothing justifies the conclusion of that anthropologist. His figures seem to be decisive. Carefully compiled statistics show that the number of negroes imported into the United States can not have exceeded four hundred thousand, while the colored race in the country now comprises about five million persons, and is largely composed of mulattoes. Dr. Nott admitted that his statements concerning the debility of the mulattoes applied only to those of South Carolina, and that in Louisiana, Florida, and Alabama, the children of the negro and white were well-formed and prolific. He explained the difference by saying that the Englishman is the only true white, and can not produce a robust offspring with the negro, while the Spaniard and Frenchman, already mixed, are more allied to him, and will cross fruitfully with him. This strange theory is easily refuted by historical arguments. So Dr. Nott's testimony confirms our theory, at least for the three more Southern States. It is shown, then, that the mixed race of black and white is increasing in the southern part of the Union as well as in South America. We can not doubt that, in a future the remoteness of which is dependent on the disappearance of existing prejudices, a fusion will take place between the men of color and the whites.

* "Some American Illustrations of the Evolution of New Varieties of Man," by Daniel Wilson, LL. D., F. R. S. E., University College, Toronto.

The facts related by Mr. Wilson concerning the crossing of the whites with the red Indians and the native races of the North are very instructive. Half-breeds of the local races have associated with Europeans, and been accepted as on terms of equality for a long time. The case has been regarded, however, as exceptional, and it has been believed that ultimately the Indians would be represented only by the relics buried with them in their tombs. Another belief is now gaining ground, that the Indian is not disappearing, but that a mixed race, full of vigor, is being developed faster than superficial observations have enabled us to perceive, and that the indigenous ethnological element is a factor of the population which is destined to exercise a permanent influence upon the Europeo-American race. The official reports show that the Indians have borne the test of endurance everywhere that they have been put upon reservations, as well as everywhere that they have been permitted to associate on equal terms with whites. Sufficient account has not been taken of the fact that the Indian population which thus gives so good an account of itself is not of pure blood. In the territory of the Hudson Bay Company alliances have been formed between both Scotch immigrants and Canadian-French and the Indian women. The difference in paternity is revealed in the offspring, but in both cases the half-breeds are a large race and robust, have greater powers of endurance than the pure Indians, and are intellectually their superiors. Dr. Kane and Dr. Rae have noticed that the half-breeds of Greenland and Labrador are superior in every way to the pure Esquimaux. In these remote regions the mixed race may become fixed and endure; but, where contact with the white race is more constant and is renewed more frequently, the pure Indian blood will continue to diminish, and will at last disappear, not by extinction, but by absorption. Numerous facts may be adduced to show that this is taking place among the Sioux, among the Cherokees, and among the Indians of Canada. After several crossings the descendants at last pass for whites, and are lost from the account of the Indians, though still transmitting Indian blood. A Huron chief at Jeune-Lorette, Canada, had four children, three daughters and a son. Two of the daughters married French-Canadians, and the other daughter an Irishman; the son married a Scotch-Canadian woman. The children of the three daughters pass for Europeans, and only those of the son for Indians or half-breeds, although they are all mixed in an equal degree. The same is likely to take place in innumerable cases. Moreover, the white men select the most promising Indian girls, so that the Indians, by this process, give up their best stock to swell the account of the white race.

In the United States and Canada the numerical preponderance and constant influx of Europeans have, if we may use the term, masked the mixed race; but, in the border regions and the Northwest and in the Hudson Bay Company's territory, the local race and the settlers occu-

py, in consequence of the superior numbers of the native race, a position analogous to that which they hold in Mexico and Central and South America. Marriage with Indian women is inevitable, and families of a mixed race are growing up everywhere, sharing the ideas and habits of the European father, and destined to mingle with the civilized community on a footing of equality.

These facts show that man is everywhere the same, and that his passions and instincts are independent of the differences that distinguish the human groups. The reason of it, says M. de Quatrefages, is that these differences, however accentuated they may seem to us, are essentially morphological, but do not in any way touch the wholly physiological power of reproduction.

RECENT GEOGRAPHICAL EXPLORATION.*

By Chief Justice DALY.

BEFORE entering upon an account of the geographical work of the world during 1878 and 1879, I would call attention to the great increase during the last few years of geographical societies. Eight have been formed within the last two years alone, and there are now throughout the world fifty-one of these organizations; the last two being one in Algeria and one in Japan. Our own society is the fifth in the number of members, though, as respects its annual revenue and ability to aid in the work of geographical exploration, it is much below bodies in Europe inferior to it in point of numbers. The oldest is the French Geographical Society of Paris, established in 1821; the largest and the most influential are the Royal Geographical Society of London, which has 3,337 members, and an annual income of about $40,000, and the Imperial Geographical Society of St. Petersburg, with an annual income of about $33,000, $12,000 of which is contributed by the Russian Government.

In the department of physical geography, much interesting work has been done. Sir Wyville Thomson, as the result of observations made by him, chiefly in the scientific voyage of the Challenger, finds that many of the physical conditions of the globe depend upon its division into two hemispheres, one embracing nearly the whole of the dry land, and the other almost all the water. He says that all the vast mass of water, often two thousand fathoms in thickness, lying below what he calls the neutral land, moves slowly northward, and that this motion is due to the trade-winds. It is now established, he states, that the average depth of the ocean is about two thousand fathoms, and that

* Abstract of the last annual address before the American Geographical Society by Charles P. Daly, LL. D., President.

it probably nowhere exceeds five thousand; that in depths of about two thousand fathoms there is the *globigerina ooze*, a substance resembling chalk, formed of the shells of living organizations that existed on the surface of the sea, and sunk to the bottom on the death of the animal. This ooze occupies considerable portions of the bed of the Atlantic, Pacific, and Southern Oceans. In depths below three thousand feet an extremely reddish clay is found, which is apparently the decomposition of submarine volcanoes and of decomposed organisms. What is at present forming a great depth does not correspond, either in structure or chemical composition, with any known geological formation, and warrants the belief that none of the older formations of the globe were laid down at such great depths. Sir Wyville Thomson adopts the opinion of Professor Dana, of Yale College, that the eruptions which originated the mountain-chains that form the skeleton of our present continents, and the depressions occupied by our present seas, arose from the cooling and contraction of the crust of the earth at a period more remote than the deposition of the earliest fossiliferous rocks.

Dr. Kroll, of Göttingen, has also been engaged in investigating the depth of the ocean, and estimates the mean depth at 1,877 fathoms, an estimate not very much below that of Sir Wyville Thomson.

In meteorology the most notable phenomena have been the very marked changes of the ordinary temperature in different parts of the world, particularly in western Europe, in certain parts of Asia, and in the eastern portion of the United States. It has been marked in Europe by winters of increased severity and an undue prevalence of moisture in the spring and summer, attended by very disastrous consequences to agriculture in Great Britain, France, and some other countries. The last winter on the European Continent, as well as in Great Britain, has been one of the severest upon record. In France the thermometer has never been so low since 1795, with the exception of one year, 1871, when the cold, however, was but of short duration. In Switzerland and southern Germany, especially in the mountainous parts, the severity of the winter has been exceedingly disastrous; while in this country the winters—especially the present winter—have been of unusual mildness in all the States east of the Mississippi.

In Asia the changes in the ordinary temperature have been equally remarkable. In the mountains of Cashmere there was a snowfall last winter extraordinary even in that mountainous region. In certain places it snowed uninterruptedly and heavily for ten continuous days, the snow upon the level plains being from thirty to forty feet deep, and in some of the mountain-passes it was piled up to a height of one hundred and fifty feet, and in others to two hundred and fifty feet.

Various conjectures have been advanced as to the cause of this unusual change of temperature. A writer in the "New York Herald" attributes the fact that the spring and summer in Europe was exces-

sively rainy to an unusually vigorous movement of the Gulf Stream, in consequence of an exceptional pressure of the southeast trade-winds, which he claims produced an extensive diffusion of Gulf vapor in a northerly direction, greatly mitigating the winds in the United States. Others attribute these effects to a change in the condition of the sun, which during the last year is said to have been in a state of repose that is very rare, there being no spots or eruptions visible upon its surface. The latter theorists maintain that, when the sun-spots are at the greatest height, or at their maximum, the earth receives the greatest quantity of heat; and that, when the spots are at the lowest, or their minimum, the heat is proportionately lessened. Others, however, dispute this altogether, declaring that the observations that have been made of the maximum periods of the spots on the sun's surface do not coincide, over any length of time, with the warm and cold years, and do not, therefore, justify any such inference. Monsieur de Perville, on the other hand, maintains, as the result of long observations of dry and rainy seasons in Europe, that they correspond with known changes of the moon. In connection with which I may mention, as a curious fact, derived from recent Assyrian researches, that the Babylonians and Chaldeans attributed changes in the weather to the influence of the moon, and kept up a system of regular observations of the moon for practical purposes.

The extreme dryness and consequent want of moisture for the fertilization of the fields in parts of India and China, hitherto fruitful and thickly populated, is attributed to the wanton destruction of the forests on the hillsides. In 1879 Mr. Hilliard visited the famine-stricken province of Shang-Si, in China, and found in these famine districts that the trees had been extensively destroyed, and attributes the want of moisture and the consequent infertility of the soil to this cause. Observations made in France by M. Mathieu and by M. Fautral over a period of four years, by different methods, as to the effect under trees and the effect in treeless plains, led to the same general results, which are as follows: That it rains more abundantly over forests than over open ground, especially when the trees are in leaf; that the air above the forest is more saturated with moisture than over the open ground; that the leaves of trees intercept one third, and, in some trees, half of the rainfall, and that the leaves and branches restrain the evaporation of the water which reaches the ground, moistening the earth four times as much as it is moistened by the rain that falls upon open plains.

Geographical inquiries are not limited to the discovery of unknown countries or places, but embrace the discovery of the remains of lost civilizations or cities, one of which has been discovered during the last two years. The readers of the Bible will remember the frequent mention that is made of the Hittites, a people occupying Canaan, who are described in the Biblical narrative as being commercial and military,

and in whose country Abraham bought a piece of land for his burial-place. The scattered accounts in the Bible simply indicate an ordinary tribe of people, with whom the Israelites had intercourse, but information derived from the researches made in Egypt and Assyria show that the Hittites, whom the Egyptians called the Kheta, and the Assyrians the Khatti, were a powerful confederacy occupying the country which was the highway between Babylonia or Assyria and Egypt—a people actively engaged in commerce, their principal city being a place at which merchants from all parts congregated, and who were at the same time a warlike people, who for a long period kept the Assyrians in check, and who proved the most formidable antagonists the Egyptians ever encountered. They were not only commercial and warlike, but had evidently at a remote period made great advances in civilization and in the fine arts, and early Greek art, as found in the discoveries of Dr. Schliemann at Mycenæ, and the early art found in Cyprus by General di Cesnola, is supposed to have been largely derived from them. They occupied the whole country of southern Syria, from the Mediterranean to the desert, dwelling chiefly in the fertile valleys of the Orontes, a river rising to the east of Baalbek and flowing into the Mediterranean, and had two principal cities—Kadesh, or the holy city, and a great commercial emporium, which was their capital and the center of their power, called Carchemish. They were finally overthrown by the Assyrians B. C. 718, and had so completely disappeared that they are scarcely even referred to by Greek writers. Great interest was felt to discover the site of their commercial capital, Carchemish, and many conjectures have been made, none of which, however, could be verified. A few years ago Mr. Skene, the British consul at Aleppo, discovered a huge mound of earth, covering a large area, on the western shore of the lower Euphrates, near Déjrabis, a ford of that river on the route still traversed by caravans. This great mound was surrounded by ruined walls and broken towers, while the mound itself was but a mass of earth, fragments of masonry and *débris*. It had frequently been seen by previous travelers, but they identified it with other lost places. Mr. Skene called the attention to it of the late George Smith, the eminent archæologist, who brought so much to light from the ruins of Nineveh, and Mr. Smith found here the long-lost capital of the Hittites. The present British consul, Mr. Henderson, has been during the last two years engaged in the exploration of the mound. He has already sent important remains with inscriptions to the British Museum, and an English traveler, Mr. Sackaw, has been recently engaged in investigating it. A few years ago a stone, which had formed part of the wall of a house at Hameth, had an inscription upon it which excited great curiosity, because it was neither Assyrian nor Egyptian, but something between both languages. It may be remembered that I called attention in one of my former addresses to the discovery of this stone and one or two others containing like charac-

ters, which were then called the Hamite inscriptions, with the suggestion that this might probably be the language of the Hittites, which is now proved to be the fact. The inscriptions found by Mr. Henderson in the exploration of Carchemish are not only in the same character, but the same language, which Mr. Layard found impressed upon seals discovered by him in the ruins of the record-chamber of Sennacherib's palace, which greatly excited his curiosity, as the writing was unlike any ever noticed before. Another inscription was afterward discovered at Aleppo by Mr. Davis, a missionary; and it also turns out that the famous figures sculptured above the roads from Ephesus to Phocea, and from Smyrna to Sardis, which are mentioned by Herodotus, and were supposed by him to represent the Egyptian King Rameses II, the Sesostris of the Greeks, have inscriptions upon them in the same character as that recently found in Carchemish, showing that these figures also are Hittite monuments. It is supposed that this language was the source of what is known as the Cypriote syllabary, found in Cyprus, a system of characters of which each does not, like the letters of the alphabet, represent a single sound, but a syllable, and which was probably the language in use among commercial people throughout Asia Minor, until it was superseded by the simpler and more practical Phœnician alphabet. This discovery is exceedingly interesting, as the Hittites belong to the same race of people who perfected, by the alphabet, that greatest of human inventions, a written language. We have now in this discovery of Mr. Smith the memorials of a lost people, in neighboring proximity to the Phœnicians; a people who had an important part in the early progress of ancient civilization, with respect to which an eminent Egyptian scholar expresses his conviction that future discoveries in the course of this exploration will afford convincing proofs that this civilization, which was of the highest antiquity, was of an importance which we can only guess at.

What may be anticipated when scholars are able to read these inscriptions, as in all probability they will be, for the cuneiform or arrow-headed characters of Assyria have been read, is foreshadowed by what has been brought to light by the discoveries of Layard and Smith in the mound which now represents what was once Nineveh. Beneath a mass of rubbish were found the remains of what had been a great Assyrian library, the materials of which being of baked clay had proved indestructible, and, though lying in broken fragments, Mr. G. Smith was able to piece the fragments together, and recover over three thousand inscriptions, forming pages of the volumes of which the library was composed, and in some cases recovering entire books. The tablets or leaves of these volumes or bricks, as they are called, are formed of thin plates of clay, upon either side of which the text was inscribed when the clay was soft, the tablet being afterward baked or dried, when the tablets or bricks, like our modern books, were arranged in chapters and volumes. Nearly two thirds of this library are now in the

British Museum, which, through the politeness of Mr. R. H. Major, I had the pleasure of inspecting in 1874. It embraces treatises on history, astronomy, geography, religion, morality, astrology, and other subjects. From one of these books, compiled after the manner of our modern encyclopædias, and the compilation of which is shown to have been made more than 2,000 years B. C., it has been ascertained, what has long been supposed, that Chaldea was the parent-land of astronomy; for it is found, from this compilation and from other bricks, that the Babylonians catalogued the stars, and distinguished and named the constellations; that they arranged the twelve constellations that form our present zodiac to show the course of the sun's path in the heavens; divided time into weeks, months, and years; that they divided the week, as we now have it, into seven days, six being days of labor and the seventh a day of rest, to which they gave a name from which we have derived our word "sabbath," and which day, as a day of rest from all labor of every kind, they observed as rigorously as the Jew or the Puritan. The motion of the heavenly bodies and the phenomena of the weather were noted down, and a connection, as I have before stated, detected, as M. de Perville claims to have discovered, between the weather and the changes of the moon. They invented the sun-dial to mark the movements of the heavenly bodies, the water-clock to measure time, and they speak in this work of the spots on the sun, a fact they could only have known by the aid of telescopes, which it is supposed they possessed, from observations that they have noted down of the rising of Venus and the fact that Layard found a crystal lens in the ruins of Nineveh. These "bricks" contain an account of the deluge, substantially the same as the narrative in the Bible, except that the names are different. They disclose that houses and land were then sold, leased, and mortgaged, that money was loaned at interest, and that the market-gardeners, to use an American phrase, "worked on shares"; that the farmer, when plowing with his oxen, beguiled his labor with short and homely songs, two of which have been found; and, to connect this very remote civilization with the usages of to-day, I may, in conclusion, refer to one of the bricks of this library, in the form of a notice, which is to the effect that visitors are requested to give to the librarian the number of the book they wish to consult, and that it will be brought to them; at the perusal of which one is disposed to fall back upon the exclamation of Solomon, that there is nothing new under the sun.

A very curious fact has come to light, resulting from Dr. Schliemann's discoveries in the Troad. In the lowest strata of his excavations at Hissarlik he found a vase with an inscription in an unknown language. Six years ago, the eminent Orientalist, E. Burnouf, declared the inscription to be in Chinese characters, for which he was generally laughed at at the time, from the improbability of Dr. Schliemann finding, in the lowest strata of his excavations, a vase with an inscription

in the Chinese language. Now, however, it appears that the Chinese ambassador at Berlin, Li Fangpau, who in his own country is a distinguished scholar, has read and translated the inscription, which, he says, states that three pieces of linen gauze are packed in the vase for inspection, being what we, in our day, would call sending a sample of merchandise into a foreign country to create a demand for it. E. Burnouf previously declared that the inscription was to the effect that the vase contained pieces of goods (*pièces d'étoffe*). The Chinese ambassador fixes the date of the inscription as about 1,200 B. C., and further states that the unknown characters so frequently occurring on the terra-cotta are also in the Chinese language, which would show that, at this remote period, commercial intercourse existed between China and the eastern shores of Asia Minor and Greece.

There have been a number of discoveries throwing light upon the question of the antiquity of man. The latest conclusions upon this subject have been given by Dr. E. B. Tylor, President of the Anthropological Institute of England, one of the most eminent men in this field of inquiry. He states, as the result of the evidence so far obtained, that the causes which brought about the differences in the form of the skull, the color of the hair and skin, and the physical constitution of men, had chiefly accomplished their work long anterior to the dawn of history; since when, he says, some changes may be traced, brought about by migrations or the effects of climate. He declares that the ground taken by Principal Dawson, of Montreal, the eminent geologist, fixing the period of development at about 2,200 years B. C., is bringing it within the historic period, and that it has nothing, as shown by the Egyptian and Assyrian researches, to support it. Mr. Tylor states that the evidence now accumulated strengthens the probability that all men are descended from one original stock, which, he thinks, is inferable from the close resemblance of all human beings in body and mind, and from the freedom with which races intercross and produce mixed races. He thinks that the period anterior to history was one of vast length. He states that anthropologists now consider the Egyptians as belonging to an African rather than to an Asiatic race, as has been previously supposed. The reasonable conclusion, he thinks, is that they were a mixed race, but mainly of African origin, and that they came originally from the southern Somauli-Land, which, according to Egyptian tradition, was the place whence their gods were derived. His further conclusion is that the Chaldeans and Babylonians, as indicated by their early languages, the Accadian and Medic, were of a Tartar or Turanian family, and may possibly have belonged to the yellow races of China, while the Assyrians were of the white race; and he thinks that the conclusion of many naturalists is correct that the geographical center from which man emanated and spread over the globe was in the tropical regions of the Old World.

Dr. R. Fahn, on the contrary, who has been making extensive lin-

guistic researches in South America, comes to a totally different conclusion from Mr. Tylor. The Doctor, in a communication published in Vienna, claims as the result of his researches that America is the Old World, and Europe, Africa, and Asia the New. He declares that the languages spoken by the Indians in Peru and Bolivia exhibit astounding affinities with the Shemitic languages, and especially with Arabic, with which the Doctor is thoroughly acquainted. He claims that the Shemitic roots are universally Aryan, and that the stems of all the varieties of the early Aryan tongues are found in their purest condition in the languages of the Indians of Peru and Bolivia, especially in the Quichua and the Aimara; and he maintains that the high plains of Bolivia and Peru are the central point from which the human race dispersed, which accords with the view expressed by some American archæologists that America is not only geologically but ethnologically the Old World.

Professor Mudge has gone into a calculation of the number of years to which the existence of man upon the globe may be traced, basing his calculation upon the rate at which the delta of the Mississippi is deposited. He reaches the conclusion that man has been on the earth not less than two hundred thousand years. Such computations, however, are, as Lyell has shown in respect to the deposits of the Nile, very uncertain data upon which to found any exact estimate of time.

The most important events in Arctic exploration have been the dispatching of the steamer Jeanette by James Gordon Bennett, and the accomplishing of the northwest passage around Asia by Professor Nordenskjöld.

The object of Professor Nordenskjöld's expedition was not only to accomplish what had been attempted so many times without success, but also the acquisition of important scientific information, it now being the opinion of meteorologists that the climate of Europe and America is materially affected by the ever-changing ice and other physical conditions of the Siberian seas; and that we shall never get a thorough understanding of the laws which regulate the movements of the winds, and the great currents of the sea, until we obtain a more thorough knowledge of the state of things in the polar basin.

The success of Professor Nordenskjöld in achieving this long-sought passage was due to the fact that he is himself an eminent scientific man; that he had a large experience previously in polar exploration, and that before undertaking this expedition he carefully studied everything that had been done, from the first attempt, in the reign of Elizabeth, down to the last expedition. He left Gothenburg on July 4, 1878, and arrived at Yokohama, Japan, on the 18th of the same month, a year later. Two hundred and sixty-four days of this time, the vessels were imprisoned in the ice off Cape Serdze, about one hundred and twenty miles from the Pacific termination of Behring Strait. The results arrived at by Professor Nordenskjöld are that the

voyage from the Atlantic to the Pacific, around the north coast of Asia, may be made by a suitable steamer in a few weeks at the proper season, but that the route is not likely to be of any practical commercial importance; that there is no difficulty in establishing a regular communication by water between the rivers Obi and the Yenisei and Europe for the purposes of trade; that in all probability the voyage by sea between the Yenisei and Lena, and between the Lena and Europe, may be utilized for the purposes of trade; that the voyage there and therefrom may be made in the same summer; and that further explorations are necessary to determine whether a practicable communication by water can be established from the river Lena to the Pacific.

Geological and geographical work in the United States has been pushed with vigor, and some interesting results developed. Mr. G. K. Gilbert has surveyed the Henry Mountains of southern Utah, discovered by Professor Powell ten years ago, and has reached the conclusion that the Saskatchewan River, which rises in the Rocky Mountains, was formerly the upper course of the Mississippi, and flowed to the Gulf of Mexico, until, by the rising of the land in Minnesota, a barrier was created which changed the course of the river, and by which Lake Winnipeg came into existence.

Professor J. W. Powell has transmitted to the Government a report on the lands of the arid regions of the United States, west of the one-hundredth meridian and east of the Cascade Range, from which it appears that the abundant rainfall in the eastern portion of the United States diminishes westward, until at last an arid region is reached, in which agriculture is not possible without irrigation. This region, Professor Powell says, begins about midway in the great plains and extends across the Rocky Mountains to the Pacific Ocean, except that there is a greater precipitation of moisture in western Washington and Oregon, and the northwest corner of California, the winds impinging on this region being freighted with moisture, derived from the great Pacific currents, and where this water-laden atmosphere strikes the western coast in full force, as it does in the vicinity of the Columbia River, the precipitation is excessive, but rapidly decreases eastward to the summit of the Cascade Mountains, this humid area being designated by the Professor as the Lower Columbia region. The especially arid portion is the great Rocky mountain region of the United States, and embraces more than two-fifths of the whole country, excluding Alaska.

One of the curious results that surveys in this country have brought out is, that the configuration of a portion of central New York has been incorrectly described and mapped. Mr. J. T. Gardiner, who had charge of the survey, states that in nearly every instance places were misplaced one or two miles, while, in respect to the general features over which the survey extended, Mr. Gardiner says, "Colorado was not a greater surprise to me than has been the structure of my native

State," and that "the configuration of the country is as unique and as unknown to science as that of any part of the Rocky Mountains."

In South America a number of surveys have been made, one of the most notable being that of the São Francisco River, by W. Milnor Roberts, now chief of the Brazilian railways. It is, he says, a very peculiar river, thirteen hundred and two miles long from the ocean to the Falls of Perapora, and is one half wider than the Ohio at Cincinnati, with a large volume of water at the lowest stage of the river. Two hundred miles from its mouth are the great Falls of Paulo Affonso, with a higher elevation than the Falls of Niagara, though not like Niagara in one pitch. A railway is required seventy-five miles to connect the lower and upper rivers, which is now, he says, in the course of construction by the Brazilian Government. About two hundred and sixty miles of the river has many rapids, all of which he ascended, and after this there are, he says, about eight hundred miles of fair navigation for light steamers.

The geographical explorations in Asia, especially in the northern part of it and in the countries now under the control of the Russians, have been very extensive. One of the most interesting events in the East has been the visit of Mr. C. Doughty to the so-called rock city of El-Heggi, beyond Damascus, which, in the days of Ptolemy, was an emporium for trade in frankincense and gold. It is one of the seven fabled cities of the Arabs, which was said by them to have been hewed out of the surrounding mountains, and to have had one hundred funereal chambers excavated in the rock. Mr. Doughty reached the place with great difficulty, and found it to consist only of the remains of what appeared to have been four or five palm villages, each surrounded by a wall in the ordinary Arab manner. He discovered some sepulchral chambers, but they were very plain, with inscriptions cut in a panel over the doorways. This journey of Mr. Doughty has entirely dissipated the fabulous stories so long told about this place by Arab, Turkish and Persian pilgrims.

The work in China, Thibet, Corea, India, Japan, and throughout all parts of Africa, has been considerable. The Niger, after several unsuccessful attempts, has been traced to its source in the vicinity of a village called Konlako, near the frontier of Koronko. Lieutenant Savarin de Braza, after three years of very difficult exploration, has obtained a complete knowledge of the Ogowa River, which he has proved to be entirely distinct from the Congo, and to have no connection with any interior lakes.

The most remarkable of the recent explorations in Africa is that of the Portuguese explorer, Major A. A. de Serpa Pinto, in his journey from Benguela, on the western coast, across the African Continent to the Zambesi River, and thence in a southeasterly direction through the Matabeli kingdom and the Transvaal Republic to Natal on the Indian Ocean. He started from Benguela, on the west coast, Novem-

ber 12, 1877, and arrived at the end of his journey in Durban, on the Indian Ocean, on April 14, 1879, a journey occupying nearly twenty months. He discovered the source of the river Cubango, west of Bihé; and, shortly afterward, two of its affluents, finding the river to be contrary to all the descriptions of it on the maps. He says, in speaking of those affluents, "I use the words small rivers, but the smallest in Africa are almost always enormous ones." He found the river Cuqueima, to his surprise, running to the north, which was contrary to its position on the maps, and flowing from the north to the southwest, toward the Quango, of which it is an affluent. He afterward struck the Quango, flowing to the north, and the Cuito, an affluent of the Cuando, running to the south. All the great rivers, he says, of South Africa, have their sources in an immense rich plain, which is in 12° south latitude. The way in which rivers in this part of Africa take their rise and are formed, as described by him, is interesting. They begin with a slight humidity, resembling the trickling of a small fountain. By degrees the current swells, and suddenly, without having received any visible affluents, it becomes an enormous river, on which any one may sail with a boat. He says he saw the source of the Cuando, first as a tiny rill, which flowed between his feet; that a little lower down he descended it in a canoe, and that thence it was quite navigable till it entered the Zambesi, where Livingstone calls it the Chobe, a name which Major Pinto says is utterly unknown at the present day in Africa. Not only is the Cuando navigable, but also many of its affluents; and there is a cataract at its extremity, which nearly proved fatal to the explorer, as it had not been previously mentioned by any one. There is, he says, no connection by water between the Cuando and the Cubango, and while in the region of the Cuando he met one of the most curious discoveries in his journey. He found that one of the carriers supplied to him by a friendly chief was, to his astonishment, a white man belonging to a race in Africa heretofore entirely unknown. This race, called the Cassequer, he says, exist in large numbers in this part of South Africa, and that they are whiter even than the Caucasians, with this distinction, that, instead of hair, their heads are covered with small tufts of very short wool, that they have prominent cheek-bones, and eyes like the Chinese. He states that he has seen girls with such a complexion that, if their features were European, they would pass in Europe for beauties. Lieutenant de Braza is of the opinion that this race of people came from North Africa, as he states that he has seen a race greatly resembling them, called the Ubamlo, south of the Congo. The men of this white African race, Major Pinto says, are remarkably muscular and robust, and that when they discharge an arrow at an elephant they bury the entire shaft in the animal's body. They live by themselves, subsisting on roots or the spoils of the chase; and it is only when their supplies fall short that they hold any communications with

their neighboring race, the Ambuelos, from whom they obtain food for ivory. He describes them as a nomadic people, never sleeping two nights in the same encampment; that they wander about in groups of from four to six families, over all the territory that lies between the Cuchi and the Cubango, and that they are the only people in Africa that do not cook their food, eating it raw. He makes the interesting statement, that it is the crossing of this people with the negroes that has produced, in his opinion, the race of mulattoes so well known in the lower part of South Africa by the name of Bushmen; a race who differ from those from which they have sprung, as they cook their food, and are of a good disposition, though quite opposed to civilization. He states that fevers prevail all along the river-banks of the Zambesi, and in the lands adjoining the river, but that the country extending inland from the highlands of Benguela is the most suitable territory in all tropical Africa for colonization, being five thousand feet above the sea, fertile, well watered, and healthy. The people, he says, are docile, capable of improvement, are very fond of dress, and that a market would here be found for the consumption of foreign manufactures.

DRESS IN RELATION TO HEALTH.*

By BENJAMIN WARD RICHARDSON.

THE character of the dress of a person stands so near to the character of the person who is the wearer of it that it is difficult to touch on one without introducing the other. All sorts of sympathies are evoked by dress. Political sympathies are in the most intimate of relationships with dress; social sympathies are indexed by it; artistic sympathies are of necessity a part of it. In a word, the dress is the outward and visible skin of the creature that carries it.

A charming and at the same time a very useful lecture might be written on the metaphysics of dress; but in this practical day, when the useful only is tolerated and the charming is considered superfluous —I mean, of course, in a lecture—I must let all attempt at such a combination fall to the ground. I must deal only with what is purely physical; the physical body and the physical stuff that is put on it—dress in relation to health.

In studying this subject I will consider the following topics:

Dress in relation to its mechanical adaptation to the body.

Dress in relation to season. I mean the amount of clothing that should be worn at different periods of the year according to seasonal changes, in this English climate.

* Lecture delivered at the London Institution on Monday, March 1, 1880.

Dress in respect to the admission of atmospheric air through it or beneath it to the surface of the body.

Dress in relation to the color of the material of which it is composed.

Dress in relation to the action of coloring substances which are introduced into its fabric and which come into contact with the surface of the body.

Cleanliness in dress.

These are all very serious subjects in respect to dress. If it were on the fashion of dress I had to treat, if I might have permission to lead you, as at a fancy-dress ball, through the historical domain of costume, then I might try to fascinate the most fastidious, and to make the time pass like a dream, in a promenade. Confined to health and dress, I can commit no ecstasy. I must be allowed to criticise, if not to scold, and rarely indeed to find one passing word that stands for commendation.

Let me, nevertheless, at once state that I have not a syllable of expression to bring forward against good fashion, and good changing fashion in dress. There is nothing whatever incompatible between good fashion and good health; they may always go well together, and they ought to go together. Naturally, I believe, they would always go together, because they are both good, and two goods can never make a bad. In like manner, bad fashion in dress and bad health go together very often, because two bads can not make a good. For my part, I have never seen a good fashion of dress that was not a healthy fashion, and the world has only been led astray on this matter by the unfortunate circumstance that it has allowed its taste to be directed by the childishness of ignorance. In early times costume, naturally enough, sprang out of innocence. Scientific rules were unknown, and, if we may take the history of primitive nations as true, artistic rules were not supremely developed or carried out. Through long ages fashions varied, mainly on the artistic side, approaching only toward scientific necessity in cases where arctic cold or tropical heat enforced some kind of consideration for the person who had to be clothed. Later in more modern and scientific times, fashion has been governed by the most superficial, vain, and imprudent of so-called artistes and fashion-leaders, who have invented modes out of their own little heads, and have set Nature at defiance, as if they were Nature, and she were an idiot—thereby changing places with her in the most complacent manner.

Let me say further even than this: I commend good fashion and fine, nay exquisite, taste in dress as a good thing of itself, independently of health. I agree entirely with Mrs. Haweis that it is the bounden duty of every woman to make herself look as handsome as ever she can. If she have natural beauty, she ought to study how to maintain it in and through every period of her life—yes—to the last;

for there is nothing more beautiful than beauty in old age. If she have moderate beauty, she should do her utmost to make the best of it. If she have no beauty, she ought to impart all that is possibly near to it by every kind of justifiable supplement. If she be positively ugly, the more is it her duty to use every legitimate art to hide the fact, and to transform even ugliness into passable presentation. Look at an ugly woman badly attired, and showing all the lines that offend taste. Look at the same woman gracefully attired and fairly, artistically gotten up, with some approach toward the beautiful, and who would hesitate to pronounce in favor of a longer *tête-à-tête* with the last of that woman as compared with the first? Why! we blockheads of men are sometimes entirely taken in by skillful, ugly women. We look upon them as handsome. The deception is justifiable, and our satisfaction is more than a recompense for our stupidity.

What is good for women is not worse for men, but I am sorry to say that men are far behind women in their endeavors to assume the beautiful. In my time I have never, off the stage, seen a man dressed many removes from the hideous. When I first began to look at my male seniors, universal black was the rage, black from head to foot; the very head, which was the only part of the animal that emerged out of darkness, rising from a broad black ring called a stock, into which the chin sometimes dropped. A little later, and an extremely tight mode of dress came into fashion, a mode which is not yet entirely discarded, but which still fits closely to those strangely occupied individuals called "copers," about whom there is a mystery as to whether their clothes were not originally and permanently modeled to their bodies. Recently there has been some attempt at improvement in English male attire. The surtout-coat, rather loosely fitting, and cut so as to hang well from the shoulders, has imported a modest but good change in fashion, while the looser and better-shaped nether habiliments have so improved in design that even the sculptors have, at last, with much compunction of conscience, ventured to reproduce them in marble.

Still, in the attire of men, and I think I must say in the attire of women also, a great deal is wanting in taste, and the most bigoted Darwinian would hardly, I think, dare to declare the doctrine of "the survival of the fittest" in respect of modern clothes, whatever he might say of the wearers of them.

I name these points that I may not be accused of feeling no care for the fashion connected with dress. I would have good fashion go with every hygienic improvement in clothes and clothing, and I know it would be easy to prove that hygiene of dress could always be combined with the most artistic and perfect of fashionable designings, by which combination health, comfort, and elegance would all be insured.

Such combination set forth as a national fashion should pass, as I think, through all classes of the community; for, assuredly, even at

this time, though it be better than it once was, few things designate classes and keep up distinctions of classes so much as the clothes that are worn, the badges, I had almost said, of the wearers. The costumes of the trim shopman, the slovenly mechanic, the country laborer, the flourishing squire, the tight-laced soldier, the club exquisite, the lugubrious doctor, the devil-may-care artist, and the awful ecclesiastic in his demented hat and sacred pinafore—these costumes and others betray a want of national taste and national unity which I for one, health-seeker as I would be, utterly repudiate. There can be no amalgamation of mind and heart while these distinctive outside declarations exist among us. In robes of office, during periods of office, men may well be distinctively clad. On the bench, at the bar, in the pulpit, in the professor's chair, such costumes are classically graceful and usefully distinctive, while in the workshop or other place of business a particular outer dress suited to the occupation is no doubt necessary; but for ordinary intercourse something in common in the way of dress were surely, in these advanced days, the thing to cultivate.

I pass now to the first head of my subject proper: Dress in relation to its mechanical adaptation to the body.

I. The first and most serious mechanical error committed on the body by dress is that of tightness, by which pressure is brought to bear upon some particular part. Presuming that an equable general pressure, not extreme in its character, and including the whole body, were applied for fitting purposes, that is to say, for the purpose of indicating outline, no great evil probably would follow from the application of such pressure, provided that it were so adapted as to give with the growth, to yield a certain measure of elasticity, and to permit perfect freedom of motion. A little more, perhaps, may be admitted even than this. In advanced life, when the shape of the body becomes irregular, and when the weight of those parts drags on the rest of the body, clothing specially adapted to those parts, and surrounding them with close and even pressure, gives useful and effective support, adding greatly at the same time, it may be, to the appearance of the body. These are exceptional conditions requiring exceptional management.

That kind of pressure to which objection must be most determinately taken is where the pressure is used, not for giving support to the body, nor for sustaining natural outline, but for the express purpose of producing an entirely artificial shape and outline. It is astonishing how resolutely the advanced professors of medicine, in all times in which they have written, have denounced the practice of compressing the body in the stages of its growth for the purpose of molding it into some unnatural form incident to fashion. It is equally astonishing to find how resolutely the votaries of the fashion have resisted the teachings of the learned, who may be said never to have made a single point in advance toward a practical victory. Now and then fashion

has given way for a short time, but it seems always to have fallen back again and resumed its place.

For my part, I can do no more than earnestly follow my predecessors and compeers in their crusade against this foolish practice, and especially against it as it affects the female part of the community. The corset and the waist-belt I must once more condemn as opposed to all that is healthful and all that is beautiful. By these appliances, through which an unequal pressure is exerted on one part of the body, the functions of the lungs, of the heart, and of the digestive organs are all kept under imperfect condition. The breathing is suppressed, the heart-beat is suppressed, the digestive power is suppressed. In this way the tripod of life —for life rests on the digestion, the respiration, and circulation—is made imperfect, and with that imperfection every other part of the body sympathizes. Of late years women have raised the cry, and I think quite properly, that they are too much subjected to the will of men, that they have not the privileges which should belong to them as fellow human beings. But, in fact, no subjection to which they have ever submitted can be greater than this to which they have subjected themselves, and I would venture to say that, while they continue this self-infliction, they can never, under any improved system of social freedom, experience the benefit of the change. If, to-morrow, women were placed in all respects on an equality with men, if they were permitted to sit in Parliament, enter the jury-box, or ascend the Bench itself, they would remain under subjection to superior mental and physical force so long as they crippled their physical, vital, and mental constitutions by this one practice of cultivating, under an atrocious view of what is beautiful, a form of body which is destructive of development of body, which reduces physical power, and which thereby deadens mental capability.

Of the two evil practices to which I refer, the tight waist-belt is, I think, worse than the tight corset, except where the corset is so adapted that it acts at one and the same time as belt and compressor general. The effect of either is to press down upon the liver and stomach, to prevent the free circulation of blood through these organs, to diminish their active physiological function, to make them descend and compress the vital organs that lie beneath them, and so to impair the growth and action of all the great secreting structures. The effect, again, is to interfere with the great breathing-muscle, the diaphragm or midriff, which divides the chest from the abdomen, and which, by its descent, causes the lungs to fill in breathing. Lastly, the effect is to press upward, and so to interfere with the heart and lungs themselves. An eminent Parisian physician, M. Breschet, recorded many years ago the facts relating to a woman who, on the right side of her throat, had a swelling which reached from the collar-bone to the level of the thyroid cartilage, and which, when the chest was tightly laced in corsets, was enlarged to its fullest. In this swelling the murmur of respiration

could be heard when a stethoscope was applied over it; but, when the chest was set at liberty and the swelling was gently pressed downward, it disappeared. In this instance, a portion of the right lung had actually been forced behind the collar-bone, out of the cavity of the chest altogether, into the loose tissue of the neck.

This was a very exceptional experience, no doubt—one I have not myself seen nor found record of in this country. At the same time, I have seen very close approaches to it. I have several times known the lungs to be pushed quite out of place and compressed toward the upper part of the thorax, and I have known the heart extremely displaced by the same pressure.

That which mothers and the guardians of youth ought to know is, not only the fact of displacement of organs under pressure, not only the fact of the temporary derangement of the function of the organs, but the further and more important fact of all, as affecting the future life of the person most concerned, that under the pressure the organs implicated can not grow so as to attain their full and complete development within the period that marks the outline of growth. It is impossible, therefore, that those who are imprisoned in growth can attain full development of body. The folly they pay for in youth extends through middle age, and expedites the decline.

The evils arising from compression of the chest, as above mentioned, are not confined altogether to the female sex. They are brought about in boys and in men. It often becomes a habit in schools and colleges for youths to employ a strap or other form of belt for holding up their trousers; one boy sets the example, and the others think it right to follow; so the practice becomes general, and you find a tight line indicating pressure marked round the bodies of these youths. Fortunately, in their case, as they emerge into life, and before great mischief is done, they give up the strap and take to supporting the clothes from the shoulders, by the brace, and so they escape further injury; but while it lasted the injury undoubtedly was severe.

There is another and more permanent injury of this kind, however, carried out by boys, even by men, which consists in wearing a belt for the purpose of giving what is called support. Boys who are about to run in races, or to leap, put on the belt and strap it tightly, in order, as they say, to hold in their wind or breath. Workingmen who are about to lift weights or carry heavy burdens put on a belt for the same purpose, their declaration being that it gives support. Actually there is not a figment of truth in this belief. It is the expression of a fashion, and nothing more. The belt impedes respiration, compresses the abdominal muscles, compresses the muscles of the back, subjecting them to unnecessary friction, and actually impedes motion. No boy would think of putting a belt tightly round the body of his pony if he wished it to win a race or to leap a hurdle; no workingman would put a belt tightly round the body of a horse to make it pull

with greater facility a load which it was drawing. On themselves they commence the practice, because somebody has set the example; then they get accustomed to the impediment, and think they can not get on without it. Drinking is learned by just the same absurd process.

I had a workingman once in my employ who would undertake no vigorous effort until he had tightened his belt. Once I got him to test what he could lift with and without the belt, and he was obliged himself to admit that he could do more without it than with it; but, he argued, he could not get on without it. That is what ladies say about corsets.

Respecting this belt for boys and men, there is a word more I must say which is of serious import. When they put on the belt for the sake of performing some feat of strength, they effect another dangerous mischief. Compressing the abdomen, they force, during the exertion, the contents of the abdominal cavity downward under pressure, giving no chance to resilience back again after the exertion or shock. In this way they frequently cause hernia or rupture. I have seen, professionally, several instances of this occurrence in boys, and among workmen who wear belts this accidental disease is so common that it is the rule rather than the exception to find it present.

Other forms of tight pressure upon the body are open to serious if not to equal objection. The wearing of shoes which compress and distort the feet is a singularly injurious custom. Suppose I said that nine tenths of the feet of the members of an English community were rendered misshapen by the boots and shoes worn, the statement would seem extreme, but it would be within the truth. The pointed shoe or boot is the most signal instance of a mischievous instrument designed for the torture of feet. In this shoe the great-toe is forced out of its natural line toward the other toes, giving a reverse curve from what is natural to the terminal part of the inner side of the foot, while all the other toes are compressed together toward the great-toe, the whole producing a wedge-like form of foot which is altogether apart from the natural. Such a foot has lost its expanse of tread; such a foot has lost its elastic resistance; such a foot has lost the strength of its arch to a very considerable degree; such a foot, by the irregular and unusual pressure on certain points of its surface, has become hard at those points, and is easily affected with corns and bunions. Lastly, such a foot becomes badly nourished, and the pressure exerted upon it interferes with its circulation and nutrition. It ceases to be an instrument upon which the body can sustain itself with grace and with easiness of movement, even in early life; while in mature life and in old age it becomes a foot which is absolutely unsafe, and which causes much of that irregular, hobbling tread which often renders so peculiar the gait of persons who have passed their meridian.

It sometimes happens for a time that these mistakes in regard to

the boot and shoe are increased by the plan of raising the heel and letting it rest on a raised impediment of a pointed shape. Anything more barbarous can scarcely be conceived. By this means the body, which should naturally be balanced on a most beautiful arch, is placed on an inclined plane, and is only prevented from falling forward by the action of the muscles which counterbalance the mechanical error. But all this is at the expense of lost muscular effort along the whole line of the muscular track, from the heels actually to the back of the head—a loss of force which is absolutely useless, and, as I have known in several cases, exhausting and painful. In addition to these evils arising from the pointed heeled boot, there are yet two more. In the first place, the elastic spring of the arch being broken by the heel, the vibration produced by its contact with the earth, at every step, causes a concussion which extends along the whole of the spinal column, and is sometimes very acutely felt. In the second place, the expanse of the foot being limited, the seizure of the earth by the foot is incomplete both in standing and in walking, so that it becomes a new art to learn how to stand erect or to walk with safety.

Another form of constriction in dress is that produced by the garter. By this pressure a line of depression is often produced quite round the limb below the knee, and the course of blood through the veins from the foot and leg, into the body, is seriously impeded. This is one cause of varicose veins, sometimes an original cause, and always a serious impediment to recovery when, from any other reason, the enlarged or varicose vein is already present. The ligature or band called the garter is bad in any way, but is far worse when it is worn below than above the knee, for above the knee the two tendons, commonly called ham-strings, receive the pressure of a great portion of the bandage, and act as bridges to the veins which pass beneath.

In men I have seen mischief from the tight cravat and collar, the pressure caused by the same leading to an obstruction to the due return of the blood from the brain. This, in persons of plethoric habits especially, is a danger not to be disregarded, and, though it may be of comparatively rare occurrence, it is worth mentioning. I have more than once in my life had occasion to see the injurious results produced by it.

I have now referred to the four varieties of pressure which are the most injurious in dress: pressure at the waist; pressure at the foot; pressure round the leg; and pressure round the neck. I place them in the order of their importance, but the first undoubtedly outweighs the others altogether.

It is actually impossible to overstate the physical injuries which result from these mistakes in bodily attire. I have told some of them. I reserve one which I will state before I pass to a new section. It will, perhaps, influence some who are comparatively thoughtless on this subject; it will, I am sure, influence all sensible and thoughtful

people. It is this observation, that the mischiefs inflicted by mode of dress become hereditary in character. I do not mean to say that, because a person produces in himself or herself a deformed waist or foot, by dress, therefore that particular deformity will be physically hereditary in the offspring of such person. I think the evidence is rather against that view, because it would seem that the Chinese children, born of mothers whose feet have been mechanically distorted, are born with feet which would come to a natural condition if they were not bandaged in infancy in the same manner as the mothers' were. But of this I am sure, that the hereditary tendency to commit these deforming acts is hereditarily received and hereditarily transmitted, and that the sense of desire for the performance of the act is also transmissible. This, in fact, is one of the great difficulties which we teachers have to overcome. We have to fight against inbred proclivities, which are so deep rooted that I believe if all the women of England at this time could, by a voluntary act of education, be led to give up tight lacing, another generation, perhaps two generations, would have to live before the practice was entirely abolished.

The lesson we have to learn and practice in respect to the mechanical arrangements of dress so far is, that every plan which leads to irregular tightening of the body should be given up. The corset and waist-strap should especially be abandoned, and our young girls should be taught to grow up just as their brothers grow, without ever learning the sense of false support which the corset soon suggests as a necessity. With the members of both sexes a reform should be introduced in the matter of boots and shoes. The tight boot should be entirely discarded, and that boot preferred which approaches nearest in form to the natural foot. Mrs. Haweis and others have insisted on the removal of the raised heel altogether from the boot, with which I entirely agree. Anatomically and physiologically it is a complete mistake to have the heel raised from the ground beyond the level of the palm of the foot. The moment the heel is raised, the plan of the arch is deranged, and the elastic, wave-like motion of the foot impeded. The arch ought always to have full play, and Mr. Dowie's plan of introducing an elastic connection or band across the arch, so as to allow it freedom, is an admirable device.

The method by which clothes should be supported on the body is another extremely important subject in connection with dress, and especially in relation to the dresses worn by women. Copying probably from an Eastern custom, and from the primitive method of wearing a girdle, it has become a habit endorsed by long centuries of use for women to carry all their long, flowing robes from the waist. These, tied one over the other, layer upon layer, and with sufficient tightness to enable the garments to be borne by the actual pressure upon the waist, are as great an incumbrance to the wearer as the corset. Indeed, it is sometimes argued that the corset is necessary, in order that

the pressure may be sustained, the corset itself acting as a kind of shield between the body and the bands, and acting also in some way like a shoulder for supporting the bands. When the dresses which are thus sustained are short and of light texture, the weight and incumbrance are considerable; but when the dresses are long, when they trail on the ground, and when they are made of heavy material, the weight and incumbrance are drags on the life, which I suspect the strongest man could not sustain while engaged in his ordinary avocations.

I am rejoiced to see that ladies themselves, who are writing intelligently on this topic, are earnestly teaching in respect to it what is both common sense and common humanity. I agree with these that the tax of carrying clothes from the waist is utterly unjustifiable, and that the parts that should bear the burden are the shoulders and none other. In this regard women ought to be placed under just the same favorable conditions for movement of the body as men, and the greatest emancipation that woman will ever have achieved will have arrived when she has discovered and carried out this practical improvement.

In saying this I do not for a moment wish to suggest that the outward appearance of the feminine dress should be like that of the masculine dress. To the woman, the flowing robe which even trespasses a little on the ground is most graceful, and is signally characteristic of feminine beauty. I would, therefore, that it should remain in all its gracefulness, but in so far as everything else is concerned, for every circumstance in which health is involved, for warmth, for freedom of movement, for mode by which the dress is carried from the shoulders, I would say, Let the women have all the advantages which now belong to men.

For any one who will for a moment think candidly must admit that the dress of men, however bad it may be in taste, or in whatever bad taste it may have been conceived, is, in respect to health, infinitely superior to that of women. In the dress of the man every part of the body is equally covered. The middle of the body is not enveloped in a number of close layers, while the lower limbs are left without close clothing altogether. The center of the body is not strained with a weight which almost drags down the lower limbs and back. The chest is not exposed to every wind that blows, and the feet are not bewildered with heavy garments which they have to kick forward or drag from behind with every advancing step. The body is clothed equally. The clothing is borne by the shoulders; it gives free motion to breathing; it gives freedom of motion to the circulation; it makes no undue pressure on the digestive organs; it leaves the limbs free; it is easily put on and off; and it allows of ready change in vicissitudes of weather. These are the advantages of modern attire for the man, and all I claim is that they should, by faithful copy, be extended to the

woman, with the one exception of the graceful outer gown or robe, as a supplement to her own superior grace and beauty.

It is told of the late eminent surgeon Mr. Cline, the teacher of Sir Astley Cooper, that when he was consulted by a lady on the question how she should prevent a girl from growing up misshapened, he replied, "Let her have no stays, and let her run about like the boys." I gladly reëcho this wise advice of the great surgeon; and I would venture to add to it another suggestion. I would say to the mothers of England: Let your girls dress just like your boys, make no difference whatever in respect to them—give them knickerbockers, if you like—with these exceptions, that the under-garments be of a little lighter material, and that they be supplemented by an outer gown or robe which shall take the place of the outer coat of the boys, and shall make them look distinctively what they are—girls clothed *cap-à-pie*, and *well* clothed from head to foot.

In speaking of these mechanical arrangements of dress I have as yet made no mention of the throat and the head as parts requiring to be clothed. In suggesting that girls should be clothed as fully as boys, I have incidentally conveyed that the chest of the girl should be covered, and I would add that in both sexes the throat should be covered also during the period extending from October to April. The throat is one of the most important parts to protect, and it is, as is well known, one of the most common parts of the body to become affected during cold weather. In this past bad weather it has been my constant—I had nearly said, daily—observation to see some affection of the throat, attended with cold, and so often has this occurred in those whose throats have been uncovered as compared with those who have used careful moderate covering, that I can not doubt that the absence of such coverings has had, and has, a very deleterious effect.

Of coverings for the head I should say that they should be always light and free, whether a bonnet, or a cap, or a hat be the subject under dispute. I think the gypsy hat beats the Quaker bonnet for the fairer sex; and, although for men I can not say anything in favor of the tall chimney-pot that will redeem it from its ugliness, I must claim for it that, when it is light and well ventilated, it is healthy. The felt hats are too closely fitting, though some are becoming. The stiff felt hat, with narrow, turned-up brim, and which looks like a Roundhead's helmet without the metal, is in respect to health miserable, and in respect to appearance simply hideous. The most graceful of all head-dresses for either sex—and it suits either—is the fine old Geneva cap, sometimes called the "Leonardo da Vinci," which I wear on occasions, by right, as the doctor's cap of the old University of St. Andrews. It is not merely a handsome head-dress, it is healthy also, and adapts itself to heat and cold. I, for one, would willingly give up the particular privilege of wearing it, to see it more widely adopted.

II. From the subject of mechanical adaptations of dress I pass to

consider dress in relation to season; the amount and kind of clothing that should be worn at different periods of the year.

On this subject there is great contrariety of opinion, and perhaps still greater contrariety of practice. There are those who maintain that to be healthy the body should be hardened by exposure to cold, and that to wrap up and coddle is the weakest and worst of all plans. It must be admitted that there are some persons who seem to flourish under this *régime*, and who live to advanced age without suffering from cold even when lightly clad. I have known myself three men who have approached their ninetieth year, and who always vigorously refused to wrap up at all. Such persons are great examples, but they are too exceptional to be counted as safe ones. The majority of the aged die, as a rule, rapidly during the cold weather. I have known children that have lived through their childhood half clothed in coldest seasons; and these are great examples, but they also are too exceptional to be accepted as safe examples. As a rule, ill-clad children in cold weather suffer intensely, and often die.

On the other hand, no doubt, some persons do greatly over-encumber themselves with clothes; and it is curious to observe that stout persons, who are wrapped and thoroughly lapped in their own subcutaneous non-conducting layer of fat, and who are generally feeble, encumber themselves with more clothes than their lithe and spare-ribbed friends, who really require most protection.

The truth is, that extremes on both sides are bad, and that a dash of good common sense is required to equalize them.

In this climate the regulation of dress in relation to health is an actual necessity during the varied seasons that prevail. We may take it as a general rule that, when the body requires more food and more sleep to meet the cold, it requires also more clothes than it does at times when sleep and food are also less wanted. There is a very remarkable physiological truth bearing on this point which every one ought to know, inasmuch as a knowledge of it becomes a guide to us in our daily life, not only in relation to dress, but to food, exercise, labor, and repose. The truth is so practical that I dwell upon it with some detail. It is this: There are certain periods of the year, in this climate, during which, independently of our wills or our actions, we are gaining in bodily weight, while there are other periods when we are losing, both periods showing a regularity which is as singularly correct as it is singularly interesting. This truth was first discovered by my late friend Mr. W. R. Milner, for many years medical superintendent of the large prison at Wakefield. His discovery was elicited by the laborious process of weighing, daily, immense numbers of prisoners through various seasons for a long series of years. I give his results as he himself has stated them.

The prisoners were all males between the ages of sixteen and fifty, and were presumed to be in good health when sent. The cells in

which they were confined had a cubic capacity of about nine hundred feet, and from thirty to thirty-five cubic feet of air were passed through each cell per minute. The mean temperature of the cells for the entire year was 61°; the highest monthly mean, 66·5°, occurred in August; the lowest, 56·9°, in March.

The diet was uniform, with the exception of the alterations ordered by the medical officer in individual cases, and consisted of the following articles daily: Bread, twenty ounces; meat without bone, four ounces; soup, half a pint—these are equivalent to about seven ounces and three quarters of butcher's meat—potatoes, one pound; skimmed milk three quarters of a pint; gruel, one pint, containing two ounces of oatmeal. The dress was, a cloth jacket, waistcoat, and trousers; cap and stock; linen shirt; woolen stockings, drawers, and under-shirt.

The prisoners were sent out to exercise in the open air nine hours a week; the exercise was for one hour at a time; the men walked in circles, and every ten minutes they ran for a hundred and fifty yards. They were all supplied with work, and were for the most part employed in making mats and matting of cocoa-fiber and other materials; some worked at tailoring and shoemaking, and a few had other work to perform.

All the prisoners were weighed on admission, and at the latter end of every calendar month during their stay.

The number of prisoners over whom these observations extended was four thousand; the period of time occupied, ten years; the average number weighed monthly, three hundred and seventy-two; and the total number of weighings, forty-four thousand and four.

The men had all been weighed by Mr. Milner or under his superintendence, and the series of observations was unbroken.

The results of these weighings were tabulated on various bases, with a view to isolate the effect of a certain number of variable on the gain or loss of weight among these prisoners, and to determine the amount of influence exerted by each of these conditions.

The conditions selected for investigation were:

1. The season of the year.
2. The period of imprisonment.
3. The employment in prison.
4. The age of the prisoners on admission.
5. The height of prisoners on admission.

The influence exerted by each of these conditions was well marked, and, with one exception, viz., the influence of season, the deductions were such as would have been anticipated.

The first showed the influence of the season of the year on the weight of a number of men placed during the entire year under circumstances of food, clothing, and work which did not differ, and who, for the greater part of the day, were in a temperature which did not vary greatly between the hottest and the coldest months. Under such

circumstances it might be expected that the weight of the men, taken as a whole, would remain sensibly the same; and that the numbers losing or gaining, as well as the quantities lost or gained, would vary little month by month; or that, if any marked variation occurred, it would be of an accidental character, depending on the greater or less amount of sickness during any particular month. The results, however, showed that a marked periodicity existed, and that, taking an average of years, there were two distinct series of months, during the one of which there was a constant loss of weight, and during the other a constant gain, so that, if the year were divided into quarters, there was a loss during the first and fourth quarters, and a gain during the second and third.

The two series of gaining and losing months were unbroken, except in one instance. On reference to the results it was found that in November, which was in the losing series, a gain occurred. The amount gained was very small, and the discrepancy was caused by the arrival of large numbers of prisoners in September and October, who usually gained weight for a short time after they were received, so that probably this break in the series resulted from the influence of the stage of imprisonment, which rather more than balanced the influence of season. On estimating carefully the facts which showed the average gain or loss per prisoner weighed, it was seen that, beginning at December, the amount lost per man increased rapidly and very steadily till March, but that between March and April there was a very abrupt transition from loss to gain. The gains then continued till August, the amount gained increasing on the whole, by a series of jerks, each alternate month presenting a larger and a smaller gain respectively: so that, to obtain a steadily increasing series, it was necessary to couple the summer months in pairs. Between August and September a change of weight occurred, about equal in amount, but in the opposite direction to that which took place between March and April. The changes between March–April and August–September were far greater in amount than the changes which took place between any other pairs of consecutive months; and this remark applied with greater force to the percentages of men gaining or losing, and to the net gains and losses per man.

The inferences which may be fairly drawn from these observations were: 1. The body becomes heavier during the summer months, and the gain varies in an increasing ratio. 2. The body becomes lighter during the winter months, and the loss varies in an increasing ratio. 3. The changes from gain to loss, and the reverse, are abrupt, and take place about the end of March and the beginning of September.

The results, which were thus gathered from the study of a large number of periodical weighings, presented a remarkable relation to the facts obtained by Dr. Edward Smith from a series of most valu-

able and elaborate experiments which he made on the quantities of carbonic acid thrown off by the lungs at various seasons of the year. For instance, Dr. Smith found that the quantity of carbonic acid thrown off was much greater in winter than in summer. Milner's weighings showed that the prisoners lost weight in winter, when the evolution of carbonic gas was great, and gained weight in summer, when less carbonic acid was given out.

This in itself would be a striking coincidence; but it was clearly detected that a sudden change took place between March and April, and at the same time of the year Dr. Smith found that a similar change took place in the amount of carbonic acid thrown off, and that the *amount* of the change was much greater at that period than at any other time; and so much greater that the alteration struck him as being a very remarkable circumstance. Dr. Smith's observations did not extend to the August–September period, and it is, therefore, impossible to say if any equally marked change takes place in autumn. There can be little doubt that variations of temperature and of light are the principal agents in causing these changes; but it will probably be found that, in addition to the direct influence of these physical agents, a periodic action in the system adds to or diminishes the effect of those physical agencies.

From the consideration of the facts collected we may fairly infer that there is a periodic variation in the weight of man during the year, the six summer months being gaining and the six winter months being losing months. The amounts gained or lost gradually increase from the commencement till the termination of each period respectively; the change from the gaining to the losing period and the converse is, however, abrupt, and these changes take place at times not very distant from the vernal and autumnal equinoxes.

Bearing on the question thus raised by Mr. Milner, I myself, from the Registrar-General's returns, made an analysis of 139,318 deaths, occurring, from 1838 to 1853, in London, Devonshire, and Cornwall, with a view of determining what causes of death were connected with the varying seasons of the year; and the result was to discover that during the wasting season, which was by far the most fatal, those diseases were most rife which spring from exposure to cold, and which are extremely fatal under that condition. I have since then many times drawn special attention to the importance of regulating clothing so as to meet the emergency to which the body is exposed during the wasting period; and the rules I had then in my mind I would enforce now. It should be a settled practice with every person in these islands that he commence to put on warmer clothing a little before the wasting period begins, and that he continue it considerably beyond the time when the balance turns and the period of increasing weight commences.

Bearing still further on this point, I have received a most practical

note from the Rev. B. A. Irving, M. A., head master of the college, Windermere, in which the argument set forth above is fully confirmed. Mr. Irving indicates, from meteorological data, that about the 10th of May and about the 10th of November there is a remarkable fall in the mean temperature. The fall, commencing in November, continues to increase until the end of February. The pinch of cold in May is followed by warmth, which continues through the summer. The rule Mr. Irving deduces from these physical facts is, that we should be warmest clothed from the end of January to the end of February, and that summer clothing should on no account be assumed until the cold pinch about the 10th of May is well passed—say about the 15th of May. The summer dress may then be continued until the end of September; but winter clothing should be most carefully assumed before the cold pinch of November 10th—say by the 1st of November. With this sound advice I entirely agree.

Need I hesitate to say how dangerously these simple rules are ignored, and that, too, by those to whom it most solemnly applies! The delicate girl invited to the ball or evening party, in the winter season, goes there with a throat and chest exposed or partly covered, and with all her garments as light as fashion will permit them. She goes into a close room, heated to 65° or it may be 70°. She dances herself into a glow, and then, exhausted, excited, and breathless, she passes out of the room, to exchange its warmth for a temperature of 35°, or lower—perhaps below freezing-point. She takes cold, she suffers from congestion of the lungs, and, if her tendencies are in that direction, she passes into consumption. And who shall wonder?

As spring advances, dangers increase to everybody. The weather is treacherous; a bright day or two in March seems to herald summer, and the warm clothing is cast aside. Suddenly, there is a fall of temperature with a bitter east wind, and the unprepared are caught as if in a trap. They have passed the long wintry ordeal before which so many have succumbed, and they are reviving, but have not revived. In this condition they are stricken with disease, often fatal. If you study the Registrar-General's returns through the months of March, April, and the early part of May for a few years, you will see how solemnly correct is the history I am now bringing under your notice.

You will ask, What kind of clothing is best to meet the varying changes? I answer, That which combines lightness with warmth, and which absorbs the watery secretion from the body without retaining it. For underclothing I give a decided preference to silk, basing this preference entirely on practical grounds. Knitted or woven silk is at once the material which best maintains warmth, affords lightness, and transmits perspiration. If the expense of it be urged on one side, its extraordinary durability may be named as a set-off. The silk should be worn next to the skin. Over the silk, for nine months in the year at least, there should be a woolen covering which should include the

whole body. This should not be made of thick, heavy flannel, for thickness and weight contribute little to warmth, but of soft, light, fleecy material, or of that thin flannel which somewhat resembles silk in structure. The feet coverings should be of the same character, and long socks should be preferred to stockings. The upper clothing, like the under, should be of light and, at the same time, warm character, and the final overcoat or cloak should carefully vary with the season. In coldest weather fur is, I think, without doubt, the best external clothing. The overcoat or cloak should, in all cases, fit loosely to the body.

III. Connected with this part of my discourse, there comes in naturally the ventilation of clothes on the body to which I referred in the opening paragraphs. I can not too seriously express the necessity of maintaining a free ventilation. Whatever impedes the evaporation of water from the body leads, of necessity, to some derangement of the body, if not to disease; for the retained moisture, saturating the garments, produces chilliness of surface, and checks the action of the skin. Then follow cold, dyspepsia, and, in those who are disposed to it, rheumatism. For these reasons I always hold that the so-called waterproofs are sources of great danger, unless they are used with great discrimination. It is true they keep the body dry in wet weather, but they wet it through from its own rain; and when the body is freely exercised and perspires copiously during rain, shut up with its own secretion on one side of the waterproof covering, and chilled by the water that falls on the other, it is in a poor plight indeed. It had better be wet to the skin in a porous clothing. Hence, I would advise that the waterproof should only be used when the body is at rest, as when standing or sitting in the rain. During active exercise a good, large, strong umbrella—none of your finikin parasol-like pretenses—is worth any number of waterproofs.

IV. The color of the dress is another practical point of considerable moment. The "Lancet," a few weeks ago, was very much criticised for suggesting that in the cold, dark weather dresses of light color should be worn. The "Lancet," nevertheless, was right. The light-colored dress is at once the warmest and the healthiest. In the Arctic regions white is the prevailing color of the animal that most retains its warmth. The same color is also best adapted for summer wear, for that which is negative to cold does not absorb heat. The objection made to white clothing is, that it so soon becomes dirty, or, correctly speaking, that it more quickly than darker fabrics shows the presence of dirt. This might be an advantage in many cases, but I think it is fair to admit that white out and out, for all times and seasons, is not practical. The best compromise is a gray, and I wonder that in our climate that practical fact, which was once known and acted upon, has ever been allowed to die out. Those wise and discerning forefathers of ours, who utilized the serviceable gray suits,

were best informed, after all, in the matter of color of dress, for health as well as for service.

Fashion, in these later times, has misled once more, by the introduction of the incorrigible black clothing for the outer suit of men and women. The inconvenience of this selection reaches its height in the infliction it imposes on those poor ladies who, after bereavement, think it necessary to clothe themselves in unwholesome folds of inky crape. Next to the suttee, this seems to me the most painful of miseries inflicted on the miserable. Happily, it is, I think, beginning to see its last days.

V. I would make, in one or two sentences, an observation on the coloring substances that are sometimes introduced into dress, in their relation to health. When the aniline color stuffs were brought in for dyeing under-garments of red or yellow color, the dyes caused, sometimes, where they came into contact with the skin, a local irritation, and now and then even some constitutional derangement. The agents which were at work to produce these conditions were the poisonous dyes called red and yellow coralline. The local action of both these poisons is sharp, and they bring upon the skin a raised eruption of minute round pimples, which I have known to be mistaken for the eruption of measles by the unskilled in diagnosis. The irritation which attends the rash is painful, and if there be much rubbing of the part little vesicles may form and give out a watery discharge. Once I knew an eruption on the chest, caused by a red woolen comforter, attended with much nervous prostration; but, as a rule, the evil is purely local, the coloring matter being not readily absorbed by the skin. This is fortunate, for the poison would be intense if it were to enter the blood.

It is necessary at once to remove the colored garment when it is causing the local mischief, and such garments should never be worn until they have been many times rinsed in boiling water.

VI. Cleanliness in dress, the last passage in my programme, is one on which, to an educated audience, I need not dwell. Health will not be clad in dirty raiment, and those who think it can be will soon find themselves subjected to various minor ailments—oppression, dullness, headache, nausea—which in themselves and singly seem of little moment, but which affect materially the standard of perfect health by which life is blithely and usefully manifested. The want now most felt among the educated, in our large centers, is the means for getting a due supply of well-washed clean clothes. The laundry is still up a tree, and, when you climb to it, it is rarely found worth the labor of the ascent. In London, at this moment, a thousand public laundries are wanted, before that cleanliness which is next to godliness can ever be recognized by the apostles of health who feel that their mission in the world stands second only on the list of goodly and godly labors for mankind.—*Gentleman's Magazine.*

STUDIES IN EXPERIMENTAL GEOLOGY.

By STANISLAS MEUNIER.

M. A. DAUBRÉE, in his recently published "Études Synthétiques de Géologie Expérimentale" (Synthetic Studies in Experimental Geology), besides giving the results of studies on the formation of meteorites and on the production of the chemical and physical phenomena of geology, describes a series of interesting and instructive experiments upon the manner in which the mechanical operations of which the earth's strata bear witness were brought about.

M. Daubrée began this series of experiments with an investigation of the processes by which the convolutions of the stratified beds were produced. With a very simple apparatus, a frame of iron strengthened by long screws crossing two of its contiguous sides, he subjected flexible laminæ, as representing in miniature the strata of the globe, to pressures of varying energy and direction. Under these constantly measured efforts he saw reproduced all the characteristic traits of the geology of regions whose strata are warped, synclinal valleys, anticlinal crests, slopes, and reversals of strata, strata in the form of C, strata in the form of S, etc.

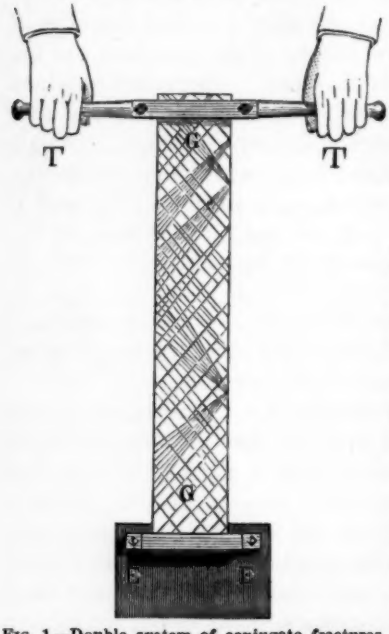


FIG. 1.—Double system of conjugate fractures developed in a plate of glass, G G, by the effect of the torsion produced by the turning-handle, T T. E E, block of wood in which the other end of the glass plate is fastened. (One sixth the natural size.)

Prosecuting his experiments beyond the limits of the elasticity of bent laminæ, M. Daubrée went into the investigation of the origin and mode of formation of terrestrial fractures. He was able by means of his new processes to produce imitations of joints and faults in all their details. An unforeseen result of his experiments was, that they disclosed evidences of mutual coordination between natural fractures which observation alone had failed to notice. This point deserves a careful examination. A rectangular plate of glass, G G (Fig. 1), was clamped between two jaws of wood tightly bound by screws so as to form a kind of vice, E E. The other end of the plate was fitted to a wrench, T T. By turning the wrench around horizontally, M. Daubrée twisted the plate of glass so that it speedily broke into a thousand pieces. Having previously taken care to paste a sheet of

paper around the glass so as to make the fragments keep their places and preserve their relative distribution to each other, he found that the fractures, instead of assuming a uniform direction, formed in the glass a network of geometrical regularity. They seemed to be grouped in two directions or systems, equally inclined to the axis of torsion. The two conjugate systems of fractures generally crossed each other at very open angles, the measure of which depended on the relative dimensions of the two sides of the plate. Sometimes the angle was a right angle, sometimes it was reduced to an angle of 70° or less.

These artificial fractures present close analogies with certain geological characteristics of different regions. An example of localities in which a correlation is presented between the subterranean fractures and the reliefs of the surface is presented in the cretaceous beds of the south of France. If we examine attentively a well-made map of this district, we shall see that from the principal valleys, which are parallel to each other, branch out a large number of other valleys, likewise rectilinear and parallel with each other. We can see in them how the thin pellicle which we call the crust of the earth has yielded to strains or torsions analogous to those which the wrench has impressed upon the plate of glass, and how it has become fissured in directions coordinate to each other. In the Spanish part of the massive Mont Perdu, the cretaceous and nummiliferous rocks, in the main horizontal, have been raised to a height of nearly ten thousand feet, and are notched to the depth of four or five thousand feet by narrow valleys, the walls of which are nearly vertical. Another example of this kind of reticulated system is presented in the forms of the coasts, fiords, and principal valleys of a part of Norway.

We already know that the schistous or leafy structure presented by many tracts called metamorphic must be attributed to real laminations. M. Daubrée has make experimental studies on the distortions which the forms of the fossils in the schistous rocks have undergone. The trilobites and mollusks of the neighborhood of Angers very rarely present themselves in any other than deformed shapes which seem like caricatures of the animals from which they are derived. These deformities can be perfectly imitated in experiments. If we inclose the shell of a crawfish in a mass of lead which we then cause to pass through a flattening-mill, we can inflict upon the crustacean a malformation quite like that of the silurian trilobites. A remarkable exemplification of the changes of form which fossils contained in rocks that have become schistous have undergone is presented by the belemnites of different localities in the Alps, in cases where they have been broken into pieces and their segments have been more or less removed from each other. M. Daubrée has produced similar forms of breakage by laminating blocks of lead in the interior of which belemnites had been previously inclosed. Fig. 2 represents a belemnite thus inclosed in a block of lead of which only a half is shown. The effect of laminating is shown

in Fig. 3: the fossil has been broken up, and its pieces have been more or less separated from each other, exactly as in the natural examples.

By pursuing a similar line of research, M. Daubrée has succeeded in imitating a characteristic feature of the structure of large chains of

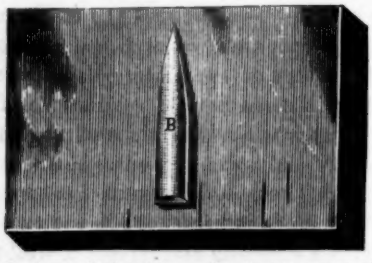


FIG. 2.—*Belemnites niger*, B, closely inclosed by casting in the center of a prism of lead; in two parts, only one of which is represented. The prism is to be subjected to the action of the hydraulic press perpendicularly to its larger sides. (Scale of one half.)

mountains, which Saussure observed on Mont Blanc. The masonry-work of Mont Blanc, says this author, is divided into great leaves having their planes exactly parallel to each other, and parallel to the direction of the chain. He further satisfied himself that the leaves,

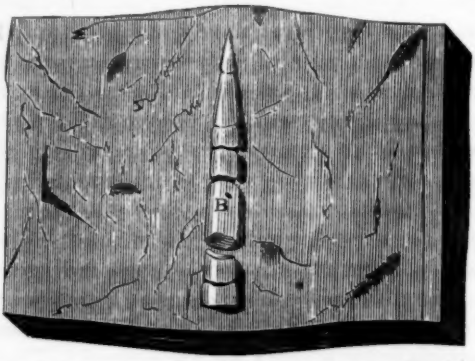


FIG. 3.—Stretching out and truncation of the belemnite of the preceding figure by the action of the hydraulic press on the prism of lead in which it was incased.

nearly vertical in the center of the mass, assumed inclined positions in their lateral parts, and dipped symmetrically toward the central axis, so as to present in their transverse section the form of a half-opened fan. Little Mont Blancs can be reproduced in miniature, with a structure like that described by Saussure, in this way: Take clay which has been previously well mixed and nearly dried, and cut into the form of a square prism; and, having put it between two square plates of the same dimensions as the base of the prism, subject it to the action of the hydraulic press. In the operation a beard (*bavure*) or overflow runs out from each of the four lateral faces, the expanding form of

which, in consequence of the change of pressure, adjusts itself with the faces of the prism. The deformed mass exhibits on a transverse fracture an essentially schistous texture, which is thus disposed: in all of the part inclosed between the plates, the leaves are nearly parallel to the two walls, but in the part which passes beyond the plates the leaves bend over and diverge from the axis so as to be parallel to the two exterior surfaces, while they themselves separate more and more. The leafiness is especially marked near the two external surfaces; it is generally much less so toward the central part. This experiment furnishes a fac-simile (Fig. 4) of the leafy structure called fan-shaped.

FIG. 4.—Production of the fan-shaped structure in a mass of clay forced to flow out from between two parallel plates. The horizontal pressure of the plates makes it take on first a leafy structure, then the fan-shaped structure as soon as it has passed beyond the limits of the plates. (One third the natural size.)

It remains to call attention to the consideration of the mechanical actions developed in the crust of the globe as the source of the heat-movements to which the metamorphism of rocks is due. M. Daubrée has been led by his experiments to conclude that such is the origin of this phenomenon. The mechanical action which is required to make rocks schistous is enough to heat them to a considerable degree. It is known that a very slight elevation of temperature is sufficient to produce chemical reactions in the depths of rocky masses. The quarry-water, with which all the rocks are impregnated, and that which finds its way to them through fissures, could give rise to reactions which might be prolonged for a protracted period.—*La Nature.*

VIEWS OF PRIMITIVE MARRIAGE.

BY LORIMER FISON.

THE theory now to be considered was first advanced by Mr. McLennan, in his work entitled "Primitive Marriage." It will be found stated in the following words in his "Studies in Ancient History,"* a reprint, with additions, of the former work:

"We believe this restriction on marriage (i. e., exogamy) to be connected with the practice in early times of female infanticide, which,

* "Studies in Ancient History," comprising a reprint of "Primitive Marriage." By John Ferguson McLennan, M. A., LL. D. Quaritch, London, 1876.

rendering women scarce, led at once to polyandry within the tribe, and to the capturing of women from without."*

"If it can be shown, firstly, that exogamous tribes exist or have existed, and, secondly, that in rude times the relations of separate tribes are uniformly or almost uniformly hostile, we have found a set of circumstances in which men could get wives only by capturing them—a social condition in which capture would be the necessary preliminary to marriage."†

Further on he remarks, "We now confidently submit that the conditions required for this inference have been amply established. . . ."‡

After a careful study of Mr. McLennan's work, I am not sure that I have grasped his meaning here. The "tribe" of which he speaks must have been in the first place endogamous, because he supposes it to have become exogamous as the result of the practice of female infanticide. Here, then, we have an endogamous tribe becoming exogamous. But, in the table of contents to Chapter VII. we read, "Conversion of an endogamous tribe into an exogamous tribe inconceivable." Turning to that part of the body of the work here indicated, we find the statement to be that the "*re*conversion of an endogamous tribe into an exogamous tribe is inconceivable." But this does not help us. For there can be no difficulty in conceiving that which we have before our eyes at the present day in almost all savage peoples on the face of the earth—a tribe endogamous *qua* tribe—that is, marrying within its own limits, and yet split up into exogamous intermarrying divisions, classes, gentes, septs, clans, thums, keelis, or whatsoever else they may be called; so that the law of marriage is distinctly exogamous. The confusion here evidently arises from want of precision in the use of the terms endogamy, exogamy, and tribe. Let us know the exact boundaries of the group to which they are applied, and then we shall be clear as to their meaning.

Again, turning to the general theory as set forth in Mr. McLennan's words already quoted, we find the following sequence:

1. Female infanticide was the general practice among the "primary hordes," and resulted in a scarcity of women, so causing polyandry and marriage by capture.

2. The tribe having thus taken to capturing women, acquired the habit of so doing, and became exogamous.

3. Exogamy having thus grown into a law, and neighboring tribes being, as a rule, hostile to one another, men could get their wives no otherwise than by capture.

Which may be fairly summed up as follows: Female infanticide causes marriage by capture. Marriage by capture causes exogamy. Exogamy causes marriage by capture.

I can not suppose this to have been Mr. McLennan's meaning, but

* "Studies," etc., p. 111. † Ibid., p. 42. ‡ Ibid., p. 109.

I have failed to perceive any other. Two things, however, are clear, as forming the basis on which his theory stands:

1. That "female infanticide" was the general practice among the "primary hordes"—in other words, that they killed many more female children than male.

2. That exogamous tribes existed under "circumstances in which men could only get wives by capturing them"—in other words, that these tribes could not marry *anywhere within their own boundaries*, and were consequently compelled to capture their wives, there being no possibility of friendly intermarriage with other tribes.

Let us now test this basis, and see if it be secure: It is well known that infanticide is a very common practice among savage and barbaric tribes, and the opinion seems to prevail that "female infanticide"—the killing of female children rather than male—is the general rule. This opinion is undoubtedly correct as to many tribes; but I venture to suggest that it needs reconsideration *as far as the lower savages are concerned*, and it is with them that the theory now under consideration has to do. I think it will be found that the practice is far less common with them than it is among the tribes who are more advanced, and for this opinion I will now endeavor to show cause.

Savages are perfectly logical people in their own way, and do not act without a motive, which, to their minds at least, is a sufficient one. So thoroughly have I been convinced of this by my fifteen years' residence among them, and close observation of their ways, that I do not hesitate to affirm that, whenever their acts appear capricious to us, we may be quite sure we do not understand their motives. The savage has no hesitation in killing his infant children, whether male or female, if they be in his way; but he does not kill any one of them for the mere sake of killing, and he certainly would not kill his daughters rather than his sons without a sufficient motive. Is such a motive to be found among the lower savages?

The reasons usually given for female infanticide are thus stated by Sir John Lubbock and Mr. McLennan:

"Female children became a source of weakness in various ways. They ate and did not hunt. They weakened their mothers when young, and when grown up were a temptation to surrounding tribes." *

To the same effect Mr. McLennan observes: "To tribes surrounded by enemies and unaided by art, contending with the difficulties of subsistence, sons were a source of strength, both for defense and in quest of food, daughters a source of weakness." †

The motive here advanced is, that *females are an incumbrance to savages*, and for this four reasons are given:

1. "They weaken their mothers when young."

* "Origin of Civilization," second edition, p. 108.

† "Studies," etc., p. 111.

2. "They eat and do not hunt"—i. e., they are food-consumers, but not food-providers.

3. They are "a source of weakness" as regards defense—i. e., they are in the way in war-time.

4. They are "a temptation to surrounding tribes."

I think it can be shown that not one of these reasons is of any force as regards the lower savages.

1. That children "weaken their mothers when young" may be a reason for infanticide, but it is no reason for killing female infants rather than male.

2. The assertion that women "eat and do not hunt" can not apply to the lower savages. On the contrary, whether among the ruder agricultural tribes, or those who are dependent on supplies gathered "from forest and from flood," the women are food-providers who supply more than they consume, and render most valuable service into the bargain. As a general rule they are the hardest workers and the most useful members of the community in times of peace.

3. And certainly they are not "a source of weakness" as regards defense. They are perfectly capable of taking care of themselves* in war-time; and, so far from being an incumbrance upon the warriors, they will fight, if need be, as bravely as the men, and with even greater ferocity. I could give some shocking proofs of this which have come under my own observation.

4. Finally, that they are "a temptation to surrounding tribes" does not appear to be a sufficient reason for killing them. They are far too valuable a possession to be cast away merely because the neighbors covet them. We do not find the Caffres exterminating their cattle because they are "a temptation to the surrounding tribes."

It is among the more advanced tribes that the motives for female infanticide are found, and I believe the practice exists also to a greater extent than among the lower savages. Thus, where a costly dower has to be given with a girl in marriage, female infanticide is known to be very common. A daughter there is a special cause of impoverishment to her parents, whereas a son is a cause of enrichment. Here we have a motive which seems to act with considerable power, but it does not exist among the lower savages. For with them the dower—where one is given—is provided by the bridegroom's kinsmen and presented to the parents of the girl. Here, then, the conditions are reversed. It is the girl who is a cause of enrichment to her

* They who are accustomed to the ways of civilized women only can hardly believe what savage women are capable of even when they may well be supposed to be at their weakest. For instance, an Australian tribe on the march scarcely takes the trouble to halt for so slight a performance as a childbirth. The newly-born infant is wrapped in opossum-skins, the march is resumed, and the mother trudges on with the rest. Indeed, as is well known, among many tribes, it is the father who is put to bed, while the mother goes about her work as if nothing had happened.

parents at her marriage. And this is very far from being all the advantage they derive from her. Her husband has to feed them in peace, and to fight for them in war. Thus an Australian native divides all the game he takes according to certain established rules, and the choicest bits go to his wife's father. That a man has to fight on his father-in-law's side among many tribes who reckon descent through females has been recorded by several observers of savage life; and it is worthy of note that this duty still devolves upon him in some tribes, which, though they have advanced to descent through males, have not yet been able to free themselves from the traditions of the older line. Thus the Rev. R. Taylor says of the Maori—who keep records, carefully carved in wood, of long lines of male ancestors reaching up to the *Nichts und Alles*—that the son-in-law had to go into his father-in-law's *hapu* (clan) and "in case of war was often obliged to fight against his own relatives.* The custom was evidently on the way to extinction among the Maori, though still retaining great strength. This is evident from the fact that there was much rebellion against it on the part of the young men, some of whom, within Mr. Taylor's knowledge, refused to obey, and lost their wives in consequence; and, whenever there is as much opposition as this to an ancient custom among savages, we may be sure that a new custom has gained a footing strong enough to afford a sanction to the malcontents. That this custom is likely to be of general prevalence among the lower savages is evident from the fact that it is the logical result of their group-relationships when descent is through the mother. Among them it is not that a man has to leave his own clan and go into his father-in-law's when he marries. He is of his father-in-law's clan by birth. Thus, if Dog and Snake be the totems, or badges, of two intermarrying clans: with descent through females the daughter of Dog is Snake, and the son of Snake is Dog. This Dog, the son of Snake, marries Snake, the daughter of Dog. That is, father-in-law and son-in-law are of the same totem, where there are but two intermarrying gentes; and a strong probability can be shown that this is the earliest form of a tribe with exogamous intermarrying divisions.

Therefore, since women are in no respect an incumbrance to the lower savages, but the reverse, it is evident that we do not find in the reasons given by Sir John Lubbock and Mr. McLennan a preferential motive for female infanticide.

And something more than this can be shown. Another motive for killing female children rather than male is found among agricultural tribes, who have descent through the father, in the fact that a woman can transmit neither the family name nor the family estate. She passes out of the line by marriage. And this with tribes who have that line of descent, and therefore—wherever they accept its consequences—ancestral worship offered to males alone by males alone, this

* "Te Ika a Maui," p. 337.

is a very grave—the very gravest—consideration. The dead are dependent upon their male descendants for offerings, without which their shadowy existence would be to the last degree wretched; and therefore, as every man knows he also must die, he is anxious during life to see a good provision made for his future wants—in other words, he is eager to have sons to succeed him. But neither is this motive to be found among the lower savages, for with them descent, and therefore inheritance, is through females. Hence we find in some such tribes the practice of "male infanticide"—that is to say, *the practice of killing male children rather than female.* Thus the Rev. R. H. Codrington, M. A., of the Church of England Melanesian mission, informed me, with regard to the people of Mota (Banks Island), that infanticide was common among them, and that "*male children were killed rather than female, because of the family passing by the female side.*"

We have seen that the first of the two postulates on which Mr. McLennan's theory depends is not to be readily granted. We have now to examine the second, which is—

That exogamous tribes existed "under circumstances in which men could get wives only by capturing them."

A tribe to satisfy these conditions must be exogamous *qua* tribe—that is to say, marriage must be forbidden everywhere within its limits. No man of the tribe must be able to take any one of its women to wife; for, if the tribe be so constituted that its men can get their wives anywhere within its boundaries, it is manifest that it is not a tribe such as Mr. McLennan's theory requires.

His list of what he calls "exogamous tribes" is contained in Chapter V. of "Studies in Ancient History," and of all those tribes there is not one which satisfies his own conditions. Without exception, they are all divided into exogamous intermarrying clans; and therefore they can get wives without capturing them from other tribes.

Each one of them is *an endogamous tribe or community, made up of exogamous intermarrying clans*—that is, it marries within its own boundaries, but it prohibits marriage within any one of its clans. Once more we have to note that a confusion arises from Mr. McLennan's want of precision in using the term "tribe," and his own terms "endogamy" and "exogamy," all of which are equally misleading, unless the area to which they are applied be clearly defined. But, whatever be the meaning which he gives to *tribe*, the cases cited by him in his fifth chapter are of no avail. For it is evident that in these cases the word "tribe" must mean one of two things: either—

1. The whole nation or community; or—

2. One of the exogamous clans—or the exogamous clans severally—into which the nation is divided.

In either case the examples cited by Mr. McLennan are valueless; because—

1. If by "tribe" he means the nation or community, then the tribes cited are not exogamous. They marry within their own bounds.

2. If by "tribe" he means the exogamous clans, then the tribes cited are not found under "circumstances in which men could get wives only by capturing them." The clans have peaceful intermarriage with one another.*

As this statement can be verified by a reference to Mr. McLennan's own account of the tribes which he cites as "exogamous," there is no need to trouble the reader with an examination of more than two or three of them which seem to require special notice. Of these the first are the Calmucks, who are divided into four great tribes or nations, called respectively Khoshot, Dzungar, Torgot, and Derbet (or Tchoro). Their system of marriage seems to have this peculiarity, that the common people can marry within any one of these great divisions, though not within certain prohibited degrees, while the nobles must marry each without his own division. A Derbet noble, for instance, we are told, must marry a Torgot lady, a Torgot noble a Derbet lady, and so on. Each of these great divisions is subdivided into smaller divisions, but we are not told whether these subdivisions are exogamous or not.

I know very little about the Calmucks, and a mission station in Feejee affording no facilities for getting at books of reference, I am not in a position to ascertain more fully the Calmuck system of marriage. We know, however, that the Calmucks call themselves the "Derben Ueirat," which means "The Four Relatives"; and this fact, coupled with the law of marriage among the nobles—who are conservatives almost everywhere, and given to standing in the old paths—seems to point to a time when the four great divisions were simply intermarrying clans, making up one community. But, whether this were so or not, it is evident that the Calmucks will not serve Mr. McLennan's turn, unless we may take it for granted that there was a time in their history when they had no way of marrying save by capturing each other's women.

Let us grant this for the sake of argument, and see what comes of it. Derbet and Torgot, we will say, are two exogamous tribes living in a state of mutual hostility, and so presenting "a set of circumstances in which men can get wives only by capturing them." Now, what is the result? Say that Derbet captures a number of Torgot women sufficient to supply its young men with wives, and Torgot captures Derbet women enough for its wants; we may then ask, "Are all the women on both sides disposed of?" If so, it follows that each tribe has captured all the women of the other.

But, if there be any women left uncaptured, what are they to do

* This has been pointed out by Mr. Morgan also. (See "Ancient Society," p. 518.)

for husbands? Say, for instance, that a number of Derbet girls are left uncaptured by the Torgots, who have secured their full complement of wives. What is to be done with them? They can not marry within their own tribe, for the tribe is exogamous. The Derbets must be in this perplexing strait: either they must give these women away to the Torgots—which would be a method of wife-procuring other than capture—or they must capture Torgot young men as husbands for those damsels, and forcibly adopt them into their own tribe.

Mr. McLennan's theory of marriage by capture, therefore, requires either—

1. That all the women of a tribe shall be captured by another tribe; or—

2. That men shall be captured for husbands, as well as women for wives. Surely, when a theory brings us to a conclusion such as this, it were better to lay it aside.

The Kocchs and the Hos, brought forward in evidence by Mr. McLennan in a subsequent chapter, are useless witnesses to him, because, as Sir John Lubbock has pointed out, "they are divided into *keelis*, or clans, and may not take to wife a girl of their own keeli."*

Concerning the Khonds, Major McPherson's statement, quoted by Mr. McLennan, is that "intermarriage between persons *of the same tribe*" (the italics are mine), "however large or scattered, is considered incestuous and punishable by death." This does not prove that no Khond can marry a Khond—and nothing less than this is required by Mr. McLennan's theory. It simply points to the fact that the Orissa Khonds are divided into exogamous clans, and that men and women of the same clan are tribal brothers and sisters.

Taking the term "exogamous tribe" to mean an exogamous community complete in all its parts, and forbidding marriage everywhere within its limits (the sense in which Mr. McLennan's theory requires it to be used with regard to the cases cited by him in his fifth chapter), I do not hesitate to say that nowhere on the face of the earth has such a tribe been found at the present day; and that we have no trustworthy record of any such tribe having existed in bygone days. All the savage communities with which we have anything like a full acquaintance are made up of exogamous intermarrying divisions, and consequently do not forbid marriage everywhere within their own limits. Such a community may properly be said to be *endogamous* as regards itself, if it forbids or at least discourages marriage beyond its own boundaries (as is frequently—we may say generally—the case), though its law of marriage can not be said to be endogamous, because its clans are strictly exogamous. There is no instance, as far as I know, of any such endogamous tribe which is not divided into exogamous clans. If we could find such a tribe, we should find what has been diligently sought for in vain for the last thirty years and more.

* "Origin of Civilization," second edition, p. 117.

It would be an undivided commune, to the former existence of which significant evidence has long seemed to point.

The case of the Ahts, quoted from Sproat's "Scenes and Studies of Savage Life," by Sir John Lubbock,* and apparently brought forward by him as an instance of such a tribe, is far from being a case in point. Sproat's account of the Ahts does not prove that tribe to be endogamous, excepting in the sense that a tribe made up of exogamous clans may be said to be endogamous because it prefers not to go beyond its own clans for its wives. If this be endogamy, then the term endogamy is of little value; for in this sense nearly every nation on the face of the earth may be said to be endogamous, in feeling at least. Even among the English the "foreigner" is not looked upon as an altogether eligible husband excepting for princesses, and for them only because of ancient traditions. It is the Calmuck rule over again. The common people may marry at home, but a Derbet noble must marry one of the Torgot stock. One of the good deeds the Queen has done is her breaking through this rule in the case of one of her daughters. And, even if one of her sons had taken an English or an American lady to wife, there is little doubt that the nation would have applauded his choice, in spite of all the old traditions. But this is going a long way from our subject.

What Sproat tells us of the Ahts is that "the idea of slavery connected with capture is so common that a freeborn Aht would hesitate to marry a woman taken in war, whatever her rank had been in her own tribe." And this feeling is a very common one elsewhere. With reference to this passage in the "Origin of Civilization," Mr. Walter Carew, Commissioner for the Interior of Naviti Levu, Feejee, was good enough to write me the following note: "To call a person 'a child of a captive' is a very great insult, even though the mother were of high rank." Mr. Carew goes on to remind me of a case, with the circumstances of which we are both acquainted, of a Viria chief who was set aside because his mother was a captive, though she was a *marama*, or lady of rank, belonging to one of the principal tribes in Feejee, a tribe of far greater consequence than that of Viria.

Having examined Mr. McLennan's theory of exogamy and marriage by capture, it now remains for us to notice his statement of polyandry.

If what we have to deal with here were no more than a statement that local cases of polyandry are to be found, or even that such cases are of frequent occurrence, the controversy would be of no very great importance. But Mr. McLennan treats polyandry as a *system of marriage* of so extensive a prevalence, and draws with singular ability such wide inferences from it as to kinship, succession, and the change of descent from the female line to the male, that all the most impor-

* "Origin of Civilization," p. 117.

tant questions connected with the development of social organization in early communities are involved. The evidence, therefore, ought to be of the very strongest, and the witnesses fully competent to deal with the facts they narrate.

In forming our opinions as to the customs of savage tribes, in all cases where the significance of a custom depends upon something underlying the visible facts, the accounts given by travelers must be received with caution. They may state quite correctly each fact they observe, but they are very likely to be wrong in their interpretation of its meaning. No witness here is to be trusted unless he has had very full opportunities of making himself acquainted with that which underlies the custom he describes. This caution has a special application to evidence as to polyandry; for, as Sir John Lubbock justly observes, "When our information is incomplete, it must often be far from easy to distinguish between communal marriage and true polyandry." * Thus Mr. Schurmann, who happened to observe two Australian blacks living with one woman in common between them, records this as an instance of polyandry, whereas we know that it was nothing more than an instance of group-marriage. So also the practice of the "imported laborers" † in Feejee at the present day might well be set down as polyandry, if we did not know what is beneath the outer fact. There is an exceptional scarcity of women among them, many more males than females being imported; and so a woman may be seen cohabiting with a number of men. But we have had more than one shocking proof that this seeming polyandry is only group-marriage in difficulties, women who admitted men of a forbidden class having been put to death by their countrymen for the offense; and the murderers have declared that they were under obligation to kill them.

Not a few of Mr. McLennan's instances of so-called polyandry admit of a similar explanation; and even those cases on which he seems chiefly to depend—the Nair and the Thibetan—are anything but conclusive in his favor. The Nair polyandry, according to the account of it given by Mr. McLennan himself in quotation from Hamilton, Buchanan, and the "Asiatic Researches," ‡ is evidently group-marriage. A Nair woman has "a combination of husbands," but "a Nair may be one in several combinations of husbands—that is, he may have any number of wives." Group-marriage might well be described in these very words. That the Nairs are divided into exogamous clans is certain from the fact that cohabitation is regulated by "certain restrictions as to tribe and caste," the plain meaning of which is that there are certain "tribes or castes" which do not intermarry; and the

* "Origin of Civilization," p. 116.

† These are natives of other South-Sea Island groups, brought to Feejee as laborers on the plantations, etc.

‡ "Studies," etc., p. 149.

Nair polyandry resolves itself into cohabitation between permitted groups. Mr. McLennan asserts that "the Nair husbands are usually not brothers—usually not relatives." But in what sense does he use "brothers" and "relatives" here? If by "brothers" he means only "children of the same parents," and by "relatives" only "persons who are related according to our own notions of relationship," then his statement is of little weight, for a group of "tribal" brothers may include many persons other than these.

The Thibetan instance quoted from Turner, where "five brothers were living very happily under the same connubial compact" * seems to be a clearer case. But there is no proof that this is an instance of true polyandry, and not of polyandry combined with polygynia, like the Nair custom, the custom of the Britons as described by Cæsar † and all the other instances given by Mr. McLennan where tribal brothers hold their wives in common. And, considering how easy it is to mistake instances of group-marriage for polyandry, such proof may be reasonably demanded from one who represents polyandry as an extensive system of marriage.

The law of the Levirate, which Mr. McLennan considers "it is impossible not to regard as . . . derived from the practice of polyandry," ‡ does not appear to me to have anything at all to do with polyandry. It was a regulation to prevent the elder branch of a stock from becoming extinct. Its underlying motive is found in the preferential claim to the birthright vested in the elder branch; and this preferential claim is found only in tribes who have descent through males, or at least who, having settled down to agriculture, are well on their way to that line. The lower savages know nothing of that motive. Mr. McLennan lays stress upon the fact that the widow was the Levir's "wife without any form of marriage." But there is no proof that this is a survival of polyandry; for, in the first place there is no need for us to look upon it as a survival of anything at all, and, in the second place, it would serve very well as a survival of group-marriage. In many tribes the brother's widow is the Levir's wife "without any form of marriage." He does not even wait until she becomes a widow. He is of the same group with her husband, and her group is "wife" to his group.

It is not denied that cases of polyandry occur. A few instances of it have come under my own observation. But in every case the men were of a clan which intermarried with that of the woman, the circumstances were exceptional, and the custom was not the general practice—not even the frequent practice—of the tribe. In full accordance with this is the following account of polyandry at Mota, written to me by the Rev. R. H. Codrington before mentioned:

"Polyandry exists, but rarely—never with young people, but mostly as a matter of convenience, as when two widowers live with

* "Studies," etc., p. 155. † "De Bello Gallico," v., 14. ‡ "Studies," etc., p. 168.

one widow. She is wife to both, and any child she may have belongs to both. There are cases in which a husband connives at a connection between his wife and another man. This is not counted adultery, for it is an open transaction; and it is not polyandry, for the parties are not counted husband and wife. It is not considered respectable."

The existence of polyandry is not denied, but I venture to hazard the assertion that it is not *the system of marriage* in any tribe at the present day, and it seems to me impossible that it could have been the rule of marriage anywhere at any time in the past. The mere arithmetical difficulty in the way appears to me to be insurmountable.

Though such statistics as I have been able to get at among the lately heathen tribes in Feejee directly contradict the hypothesis, still I think we may suppose that the number of males generally exceeds that of females among the lower savages. But it does not seem to have occurred to Mr. McLennan to consider how great his theory of polyandry as a system of marriage requires that disparity to be. Under such a system it is evident that, whatever the average number of husbands to a wife may be, at least so many times more numerous must the men be than the women. If y be the number of women, and x their average allowance of husbands; then, since we can not suppose that under such a system any marriageable girl would be allowed to roam in "maiden meditation fancy free," the number of men in the tribe must be $x\,y$, even supposing all the men to be absorbed in the "combinations of husbands."

Nor will marriage by capture help us here; because, for every woman stolen there must have been x husbands left lamenting, unless we suppose that a non-polyandrous tribe was kept in the neighborhood of each polyandrous tribe for its convenience, and that they never retaliated upon their aggressive neighbors.

To sum up: It has been shown that Mr. McLennan's postulate of female infanticide as the rule among the lower savages can not easily be granted; that his exogamous tribes are not exogamous in the sense which his theory requires; and that both marriage by capture and polyandry, as systems of marriage, involve something which has all the appearance of an absurdity. Without claiming too much, then, I think it may be said that the basis of Mr. McLennan's theory has been shown to be insecure. And this being so, it is all the greater pity that he allowed himself to treat with such contemptuous scorn the hypothesis advanced by Mr. Morgan in his work on "Systems of Consanguinity,"* which hypothesis is opposed to his own.

"This wild dream—not to say nightmare—of early institutions . . . . It seemed worth while to take the trouble to show its utterly un-

* "Systems of Consanguinity and Affinity of the Human Family," "Smithsonian Contributions to Knowledge," vol. xvii.

scientific character."* Before a writer permits himself to use words such as these, he should be very sure that he has firm ground under his feet; and even then it would be better to leave them unsaid. There is nothing in any line of scientific research to make a man of undoubted learning and ability forget the courtesy which he owes to another.

GOETHE'S FARBENLEHRE.—(THEORY OF COLORS.†)

By Professor JOHN TYNDALL, F. R. S.

I.

IN the days of my youth, when life was strong and aspiration high, I found myself standing one fine summer evening beside a statue of Goethe in a German city. Following the current of thought and feeling started by the associations of the place, I eventually came to the conclusion that, judging even from a purely utilitarian point of view, a truly noble work of art was the most suitable memorial for a great man. Such a work appeared to me capable of exciting a motive force within the mind which no purely material influence could generate. There was then labor before me of the most arduous kind. There were formidable practical difficulties to be overcome, and very small means wherewith to overcome them, and yet I felt that no material means could, as regards the task I had undertaken, plant within me a resolve comparable with that which the contemplation of this statue of Goethe was able to arouse.

My reverence for the poet had been awakened by the writings of Mr. Carlyle, and it was afterward confirmed and consolidated by the writings of Goethe himself. But there was one of the poet's works, which, though it lay directly in the line of my own studies, remained for a long time only imperfectly known to me. My opinion of that work was not formed on hearsay. I dipped into it so far as to make myself acquainted with its style, its logic, and its general aim; but having done this I laid it aside, as something which jarred upon my conception of Goethe's grandeur. The mind willingly rounds off the image which it venerates, and only acknowledges with reluctance that it is on any side incomplete; and believing that Goethe in the "Farbenlehre" was wrong in his intellectual, and perverse in his moral judgments—seeing, above all things, that he had forsaken the lofty impersonal calm which was his chief characteristic, and which had entered into my conception of the godlike in literature—I abandoned

* "Studies," etc., pp. 360, 371.

† A discourse delivered in the Royal Institution of Great Britain, on Friday evening, March 19, 1880.

the "Farbenlehre," and looked up to Goethe on that side where his greatness was uncontested and supreme.

But in the month of May, 1878, Mr. Carlyle did me the honor of calling upon me twice; and I, not being at home at the time, visited him in Chelsea soon afterward. He was then in his eighty-third year, and, looking in his solemn fashion toward that portal to which we are all so rapidly hastening, he remembered his friends. He then presented to me, as "a farewell gift," the two octavo volumes of letter-press and the single folio volume, consisting in great part of colored diagrams, which are here before you. Exactly half a century ago these volumes were sent by Goethe to Mr. Carlyle. They embrace the "Farbenlehre"—a title which may be translated, though not well translated, "Theory of Colors"—and they are accompanied by a long letter, or rather catalogue from Goethe himself, dated the 14th of June, 1830, a little less than two years before his death. My illustrious friend wished me to examine the book, with a view of setting forth what it really contained. This year for the first time I have been able to comply with the desire of Mr. Carlyle; and as I knew that your wish would coincide with his, as to the propriety of making some attempt to weigh the merits of a work which exerted so great an influence in its day,* I have not shrunk from the labor of such a review.

The average reading of the late Mr. Buckle is said to have amounted to three volumes a day. But they could not have been volumes like those of the "Farbenlehre." For the necessity of halting and pondering over its statements was so frequent and the difficulty of coming to any undoubted conclusion regarding Goethe's real conceptions was often so great as to invoke the expenditure of an inordinate amount of time. I can not even now say with confidence that I fully realize all the thoughts of Goethe. Many of them are strange to the scientific man. They demand for their interpretation a sympathy beyond that required or even tolerated in severe physical research. Two factors, the one external and the other internal, go to the production of every intellectual result. There is the evidence without and there is the mind within on which that evidence impinges. Change either factor, and the result will cease to be the same. In the region of politics, where mere opinion comes so much into play, it is only natural that the same external evidence should produce different convictions in different minds. But in the region of science, where demonstration instead of opinion is paramount, such differences ought hardly to be expected. That they nevertheless occur is strikingly exemplified by the case before us; for the very experimental facts

* The late Sir Charles Eastlake translated a portion of the "Farbenlehre"; while the late Mr. Lewes, in his "Life of Goethe," has given a brief but very clever account of the work. It is also dealt with, in connection with Goethe's other scientific labors, in Helmholtz's lectures.

which had previously converted the world to Newton's views, on appealing to the mind of Goethe, produced a theory of light and colors in violent antagonism to that of Newton.

Goethe prized the "Farbenlehre" as the most important of his works. "In what I have done as a poet," he says to Eckermann, "I take no pride, but I am proud of the fact that I am the only person in this century who is acquainted with the difficult science of colors." If the importance of a work were to be measured by the amount of conscious labor expended in its production, Goethe's estimate of the "Farbenlehre" would probably be correct. The observations and experiments there recorded astonish us by their variety and number. The amount of reading which he accomplished was obviously vast. He pursued the history of optics, not only along its main streams, but on to its remotest rills. He was animated by the zeal of an apostle, for he believed that a giant imposture was to be overthrown, and that he was the man to accomplish the holy work of destruction. He was also a lover of art, and held that the enunciation of the true principles of color would, in relation to painting, be of lasting importance. Thus positively and negatively he was stimulated to bring all the strength he could command to bear upon this question.

The greater part of the first volume is taken up with Goethe's own experiments, which are described in nine hundred and twenty paragraphs duly numbered. It is not a consecutive argument, but rather a series of jets of fact and logic emitted at various intervals. I picture the poet in that troublous war-time, walking up and down his Weimar garden, with his hands behind his back, pondering his subject, throwing his experiments and reflections into these terse paragraphs, and turning occasionally into his garden-house to write them down. This first portion of the work embraces three parts, which deal respectively with—Physiological or Subjective Colors, with Physical or Prismatic Colors, and with Chemical Colors and Pigments. To these are added a fourth part, bearing the German title "Allgemeine Ansichten nach innen"; a fifth part, entitled "Nachbarliche Verhältnisse," neighboring relations; and a sixth part, entitled "Sinnlich-sittliche Wirkung der Farbe," sensuously-moral effect of colors. It is hardly necessary to remark that some of these titles, though doubtless pregnant with meaning to the poet himself, are not likely to commend themselves to the more exacting man of science.

The main divisions of Goethe's book are subdivided into short sections, bearing titles more or less shadowy from a scientific point of view: Origin of White; Origin of Black; Excitement of Color; Heightening; Culmination; Balancing; Reversion; Fixation; Mixture real; Mixture apparent; Communication actual; Communication apparent. He describes the colors of minerals, plants, worms, insects, fishes, birds, mammals, and men. Hair on the surface of the human body he considers indicative rather of weakness than of strength.

The disquisition is continued under the headings: How easily Color arises; How energetic Color may be; Heightening to red; Completeness of Manifold Phenomena; Agreement of Complete Phenomena; How easily Color disappears; How durable Color remains; Relation to Philosophy; Relation to Mathematics; Relation to Physiology and Pathology; Relation to Natural History; Relation to General Physics; Relation to Tones. Then follows a series of sections dealing with the primary colors and their mixtures. These sections relate less to science than to art. The writer treats, among other things, of—Æsthetic Effects; Fear of the Theoretical; Grounds and Pigments; Allegorical, Symbolical, and Mystical Use of Colors. The headings alone indicate the enormous industry of the poet; showing at the same time an absence of that scientific definition which he stigmatized as "pedantry" in the case of Newton.

In connection with this subject, Goethe charged himself with all kinds of kindred knowledge. He refers to ocular spectra, quoting Boyle, Buffon, and Darwin; to the paralysis of the eye by light; to its extreme sensitiveness when it awakes in the morning; to irradiation—quoting Tycho Brahe on the comparative apparent size of the dark and the illuminated moon. He dwells upon the persistence of impressions upon the retina, and quotes various instances of abnormal duration. He possessed a full and exact knowledge of the phenomena of subjective colors, and described various modes of producing them. He copiously illustrates the production by red of subjective green, and by green of subjective red. Blue produces subjective yellow, and yellow subjective blue. He experimented upon shadows, colored in contrast to surrounding light. The contrasting subjective colors he calls "geforderte Farben," colors "demanded" by the eye. Goethe gives the following striking illustration of these subjective effects: "I once," he said, "entered an inn toward evening, when a well-built maiden, with dazzlingly white face, black hair, and scarlet bodice and skirt came toward me. I looked at her sharply in the twilight, and when she moved away, saw upon the white wall opposite a black face with a bright halo round it, while the clothing of the perfectly distinct figure appeared of a beautiful sea-green." With the instinct of the poet, Goethe discerned in these antitheses an image of the general method of nature. Every action, he says, implies an opposite. Inhalation precedes expiration, and each systole has its corresponding diastole. Such is the eternal formula of life. Under the figure of systole and diastole the rhythm of nature is represented in other portions of the work.

Goethe handled the prism with great skill, and his experiments with it are numberless. He places white rectangles on a black ground, black rectangles on a white ground, and shifts their apparent positions by prismatic refraction. He makes similar experiments with colored rectangles and disks. The shifted image is sometimes projected on a screen,

the experiment being then "objective." It is sometimes looked at directly through the prism, the experiment being then "subjective." In the production of chromatic effects, he dwells upon the absolute necessity of *boundaries*—"Gränzen." The sky may be looked at and shifted by a prism without the production of color; and if the white rectangle on a black ground be only made wide enough, the center remains white after refraction, the colors being confined to the edges. Goethe's earliest experiment, which led him so hastily to the conclusion that Newton's theory of colors was wrong, consisted in looking through a prism at the white wall of his own room. He expected to see the whole wall covered with colors, this being, he thought, implied in the theory of Newton. But to his astonishment it remained white, and only when he came to the boundary of a dark or a bright space did the colors reveal themselves. This question of "boundaries" is one of supreme importance to the author of the "Farbenlehre"; the end and aim of his theory being to account for the colored fringes produced at the edges of his refracted images.

Darkness, according to Goethe, had as much to do as light with the production of color. Color was really due to the commingling of both. Not only did his white rectangles upon a black ground yield the colored fringes, but his black rectangles on a white ground did the same. The order of the colors seemed, however, different in the two cases. Let a visiting-card, held in the hand between the eye and a window facing the bright firmament, be looked at through a prism, then supposing the image of the card to be shifted upward by refraction, a red fringe is seen above and a blue one below. Let the back be turned to the window and the card so held that the light shall fall upon it; on being looked at through the prism, blue is seen above and red below. In the first case the fringes are due to the decomposition of the light adjacent to the edge of the card, which simply acts as an opaque body, and might have been actually black. In the second case the light decomposed is that coming from the white surface of the card itself. The first experiment corresponds to that of Goethe with a black rectangle on a white ground; while the second experiment corresponds to Goethe's white rectangle on a black ground. Both these effects are immediately deducible from Newton's theory of colors. But this, though explained to him by physicists of great experience and reputation, Goethe could never be brought to see, and he continued to affirm to the end of his life that the results were utterly irreconcilable with the theory of Newton.

In his own explanations Goethe began at the wrong end, inverting the true order of thought, and trying to make the outcome of theory its foundation. Apart from theory, however, his observations are of great interest and variety. He looked to the zenith at midnight, and found before him the blackness of space, while in daylight he saw the blue firmament overhead; and he rightly adopted the conclusion that

this coloring of the sky was due to the shining of the sun upon a turbid medium with darkness behind. He by no means understood the physical action of turbid media, but he made a great variety of experiments bearing upon this point. Water, for example, rendered turbid by varnish, soap, or milk, and having a black ground behind it, always appeared blue when shone upon by white light. When, instead of a black background, a bright one was placed behind, so that the light shone, not *on*, but *through* the turbid liquid, the blue color disappeared, and he had yellow in its place. Such experiments are capable of endless variation. To this class of effects belongs the painter's "chill." A cold, bluish bloom, like that of a plum, is sometimes observed to cover the browns of a varnished picture. This is due to a want of optical continuity in the varnish. Instead of being a coherent layer it is broken up into particles of microscopic smallness, which virtually constitute a turbid medium and send blue light to the eye.

Goethe himself describes a most amusing illustration, or, to use his own language, "a wonderful phenomenon," due to the temporary action of a turbid medium on a picture: "A portrait of an esteemed theologian was painted several years ago by an artist specially skilled in the treatment of colors. The man stood forth in his dignity clad in a beautiful black velvet coat, which attracted the eyes and awakened the admiration of the beholder almost more than the face itself. Through the action of humidity and dust, however, the picture had lost much of its original splendor. It was therefore handed over to a painter to be cleaned and newly varnished. The painter began by carefully passing a wet sponge over the picture. But he had scarcely thus removed the coarser dirt, when to his astonishment the black velvet suddenly changed into a light-blue plush; the reverend gentleman acquiring thereby a very worldly, if, at the same time, an old-fashioned appearance. The painter would not trust himself to wash further. He could by no means see how a bright blue could underlie a dark black, still less that he could have so rapidly washed away a coating capable of converting a blue like that before him into the black of the original painting."

Goethe inspected the picture, saw the phenomenon, and explained it. To deepen the hue of the velvet coat the painter had covered it with a special varnish, which, by absorbing part of the water passed over it, was converted into a turbid medium, through which the black behind instantly appeared as blue. To the great joy of the painter, he found that a few hours' continuance in a dry place restored the primitive black. By the evaporation of the moisture the optical continuity of the varnish (to which essential point Goethe does not refer) was reëstablished, after which it ceased to act as a turbid medium.

This question of turbid media took entire possession of the poet's mind. It was ever present to his observation. It was illustrated by

the azure of noonday, and by the daffodil and crimson of the evening sky. The inimitable lines written at Ilmenau—

> "Ueber allen Gipfeln
> Ist Ruh',
> In allen Wipfeln
> Spürest Du
> Kaum einen Hauch"—

suggest a stillness of the atmosphere which would allow the columns of fine smoke from the foresters' cottages to rise high into the air. He would thus have an opportunity of seeing the upper portion of the column projected against bright clouds, and the lower portion against dark pines, the brownish yellow of the one and the blue of the other being strikingly and at once revealed. He was able to produce artificially at will the colors which he had previously observed in nature. He noticed that when certain bodies were incorporated with glass this substance also played a double part, appearing blue by reflected and yellow by transmitted light.* The action of turbid media was to Goethe the ultimate fact—the *Urphänomen*—of the world of colors. "We see on the one side Light, and on the other side Darkness. We bring between both Turbidity, and from these opposites develop all colors."

As long as Goethe remained in the region of fact his observations are of permanent value. But by the coercion of a powerful imagination he forced his turbid media into regions to which they did not belong, and sought to overthrow by their agency the irrefragable demonstrations of Newton. Newton's theory, as known by everybody, is that white light is composed of a multitude of differently refrangible rays, whose coalescence in certain proportions produces the impression of white. By prismatic analysis these rays are separated from each other, the color of each ray being strictly determined by its refrangibility. The experiments of Newton, whereby he sought to establish this theory, had long appealed with overmastering evidence to every mind trained in the severities of physical investigation. But they did not thus appeal to Goethe. Accepting for the most part the experiments of Newton, he rejected with indignation the conclusions drawn from them, and turned into utter ridicule the notion that white light possessed the composite character ascribed to it. Many of the naturalists of his time supported him, while among philosophers Schelling and Hegel shouted in acclamation over the supposed defeat of Newton. The physicists, however, gave the poet no countenance. Goethe met their scorn with scorn, and under his lash these deniers of his theory, their master included, paid the penalty of their arrogance.

How, then, did he lay down the lines of his own theory? How,

* Beautiful and instructive samples of such glass are to be seen in the Venice Glass Company's shop, No. 30 St. James's Street.

out of such meager elements as his yellow, and his blue, and his turbid medium, did he extract the amazing variety and richness of the Newtonian spectrum? Here we must walk circumspectly, for the intellectual atmosphere with which Goethe surrounds himself is by no means free from turbidity. In trying to account for his position, we must make ourselves acquainted with his salient facts, and endeavor to place our minds in sympathy with his mode of regarding them. He found that he could intensify the yellow of his transmitted light by making the turbidity of his medium stronger. A single sheet of diaphanous parchment placed over a hole in his window-shutter appeared whitish. Two sheets appeared yellow, which by the addition of other sheets could be converted into red. It is quite true that by simply sending it through a medium charged with extremely minute particles we can extract from white light a ruby red. The red of the London sun, of which we have had such fine and frequent examples during the late winter, is a case to some extent in point. Goethe did not believe in Newton's differently refrangible rays. He refused to entertain the notion that the red light obtained by the employment of several sheets of parchment was different in quality from the yellow light obtained with two. The red, according to him, was a mere intensification—"Steigerung"—of the yellow. Colors in general consisted, according to Goethe, of light on its way to darkness, and the only difference between yellow and red consisted in the latter being nearer than the former to its final goal.

But how in the production of the spectrum do turbid media come into play? If they exist, where are they? The poet's answer to this question is subtile in the extreme. He wanders round the answer before he touches it, indulging in various considerations regarding penumbræ and double images, with the apparent aim of breaking down the repugnance to his logic which the mind of his reader is only too likely to entertain. If you place a white card near the surface of a piece of plate-glass, and look obliquely at the image of the card reflected from the two surfaces, you observe two images, which are hazy at the edges and more dense and defined where they overlap. These hazy edges Goethe pressed into his service as turbid media. He fancied that they associated themselves indissolubly with his refracted rectangles—that in every case the image of the rectangle was accompanied by a secondary hazy image, a little in advance of the principal one. At one edge, he contended, the advanced secondary image had black behind it, which was converted into blue; while at the other edge it had white behind it, and appeared yellow. When the refracted rectangle is made very narrow, the fringes approach each other and finally overlap. Blue thus mingles with yellow, and the green of the spectrum is the consequence. This, in a nutshell, is the theory of colors developed in the "Farbenlehre." Goethe obviously regarded the narrowing of the rectangle, of the cylindrical beam, or of the slit

of light passing through the prism, which, according to Newton, is the indispensable condition requisite for the production of a pure spectrum, as an impure and complicated mode of illustrating the phenomenon. The elementary fact is, according to Goethe, obtained when we operate with a wide rectangle the edges only of which are colored, while the center remains white. His experiments with the parchment had made him acquainted with the passage of yellow into red as he multiplied his layers; but how this passage occurs in the spectrum he does not explain. That, however, his hazy surfaces—his virtual turbid media—produced, in some way or other, the observed passage and intensification, Goethe held as firmly, and enunciated as confidently, as if his analysis of the phenomena had been complete.

The fact is, that between double images and turbid media there is no kinship whatever. Turbidity is due to the diffusion, in a transparent medium, of minute particles having a refractive index different from that of the medium. But the act of reflection which produced the penumbral surfaces, whose aid Goethe invoked, did not charge them with such discrete particles. On various former occasions I have tried to set forth the principles on which the chromatic action of turbid media depends. When such media are to be seen blue, the light scattered by the diffused particles, and that only, ought to reach the eye. This feeble light may be compared to a faint whisper which is easily rendered inaudible by a louder noise. The scattered light of the particles is accordingly overpowered, when a stronger light comes, not from the particles, but from a bright surface behind them. Here the light reaches the eye, minus that scattered by the particles. It is therefore the complementary light, or yellow. Both effects are immediately deducible from the principles of the undulatory theory. As a stone in water throws back a larger fraction of a ripple than of a larger wave, so do the excessively minute particles which produce the turbidity scatter more copiously the small waves of the spectrum than the large ones. Light scattered by such particles will therefore always contain a preponderance of the waves which produce the sensation of blue. During its transmission through the turbid medium the white light is more and more robbed of its blue constituents, the transmitted light which reaches the eye being therefore complementary to the blue.

Some of you are, no doubt, aware that it is possible to take matter in the gaseous condition, when its smallest parts are molecules, incapable of being either seen themselves or of scattering any sensible portion of light which impinges on them; that it is possible to shake these molecules asunder by special light-waves, so that their liberated constituents shall coalesce anew and form, not *molecules*, but *particles;* that it is possible to cause these particles to grow, from a size bordering on the atomic, to a size which enables them to copiously scatter light. Some of you are aware that in the early stages of their growth, when they are still beyond the grasp of the microscope, such particles,

no matter what the substance may be of which they are composed, shed forth a pure firmamental blue; and that from them we can manufacture in the laboratory artificial skies which display all the phenomena, both of color and polarization, of the real firmament.

With regard to the production of the green of the spectrum by the overlapping of yellow and blue, Goethe, like a multitude of others, confounded the mixture of blue and yellow lights with that of blue and yellow pigments. This was an error shared by the world at large. But in Goethe's own day, Wünsch, of Leipsic, who is ridiculed in the "Farbenlehre," had corrected the error, and proved the mixture of blue and yellow lights to produce white. Any doubt that might be entertained of Wünsch's experiments—and they are obviously the work of a careful and competent man—is entirely removed by the experiments of Helmholtz and others in our own day. Thus, to sum up, Goethe's theory, if such it may be called, proves incompetent to account even approximately for the Newtonian spectrum. He refers it to turbid media, but no such media come into play. He fails to account for the passage of yellow into red and of blue into violet; while his attempt to deduce the green of the spectrum from the mixture of yellow and blue is contradicted by facts which were extant in his own time.

HOW ANIMALS EAT.

By HERMAN L. FAIRCHILD.

IN the digestion of the higher animals, the first act is the trituration of the food to assist and hasten its solution. We might term this mechanical digestion, as it is a reduction of the food preparatory to the essential physical and chemical process. Although very simple in

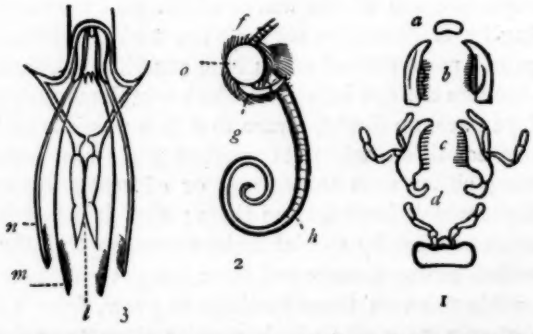


FIG. 1.—ORGANS OF THE MOUTH IN INSECTS: 1. Trophi of a masticating insect (beetle): *a*, labrum or upper lip; *b*, mandibles; *c*, maxillæ with their palpi; *d*, labium or lower lip with its palpi. 2. Mouth of a butterfly: *o*, eye; *f*, base of antennæ; *g*, labial palp; *h*, spiral trunk or "antlia." 3. Mouth of a hemipterous insect (*Nepa cinerea*): *l*, labium; *m*, maxillæ; *n*, mandibles.

purpose, the manner is exceedingly various and interesting. The mastication of food is usually accomplished by a mill in the mouth. And absence of a masticatory apparatus at the entrance of the food-canal is usually compensated by a mill within the body, as the gizzard of a bird, or by strong chemical solvents as shown in the snake.

FIG. 2.—SECTION OF TOOTH OF CAT, *in situ:* 1, enamel; 2, dentine, or ivory; 3, cement, or bone; 4, periosteum; 5, bone of lower jaw; 6, pulp-cavity.

To soften the food and so assist in its trituration, nearly all animals are provided with saliva. But, as this fluid serves to lubricate the food for swallowing, and also has a chemical power, it may be considered in connection with digestion.

Those animals which subsist wholly on liquids or on minute particles require, of course, no masticating organs. Of the first class, are most parasites, the butterflies and some humming-birds; and, of the second, bivalve mollusks and the whalebone whale. The little sea-ur-

chin is remarkable as the first animal, and below mollusks and articulates the only animal, possessing any organs for mastication. Furthermore, its dental apparatus is perhaps of greatest complexity in the whole animal kingdom. Five triangular teeth set in as many jaws surround the opening to the stomach, and move toward a central point. They seize and divide the food which then passes between the masticating jaws. The latter are grooved, and, aided by saliva, effectually crush and grind the food. The muscles and levers necessary to efficient action are numerous and intricate, altogether forming an apparatus entirely unique in form and principle.

Among mollusks the gasteropods or snails, and the cephalopods, which include the cuttle- and devil-fishes, have masticating organs. Most snails have thousands of minute teeth on the tongue. These are, however, chiefly used for procuring food by a rasping or boring motion. But some snails, not satisfied with lingual teeth alone, indulge the absurdity of carrying powerful teeth in the stomach. The beak of the cuttle-fish divides the food somewhat, but the masticating process is mainly performed by a gizzard.

Articulates have a much greater variety of masticating organs. Nearly all, even some of the worms, have efficient jaws for seizing food, which also serve to cut and crush the same.

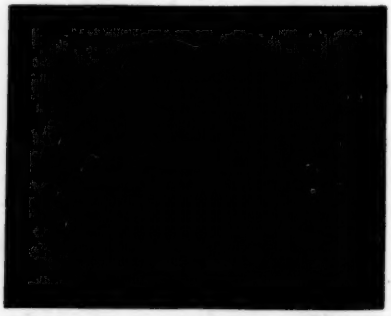


FIG. 3.—JAWS AND PAVEMENT-TEETH OF A RAY (*Myliobates*).

Imagine a creature with so little regard for the proprieties as to chew food with its legs! Yet the common limulus, or "horseshoe crab," actually grinds the food between its thighs. However, this is not so strange, when we understand that the claws of the lobster and crab are simply modified legs; and that many higher animals, the squirrel and cat, for instance, use their feet in eating.

Another group of crustaceans, the little rotifers, pound their food. The lower jaw serves the purpose of an anvil upon which the food is crushed by two hammers formed from the upper jaw. Lobsters and crabs masticate with their horny jaws; but they all have complete and efficient sets of teeth in the gizzard-like stomach. And, when the shell is cast, the teeth are also shed along with the stomach-lining. Those

members of the spider and centiped classes which eat solid matter have masticating jaws. But the best development of such jaws is found in the insects. Nearly all insects while in the larval state, and many adult insects, as beetles and grasshoppers, have two pairs of

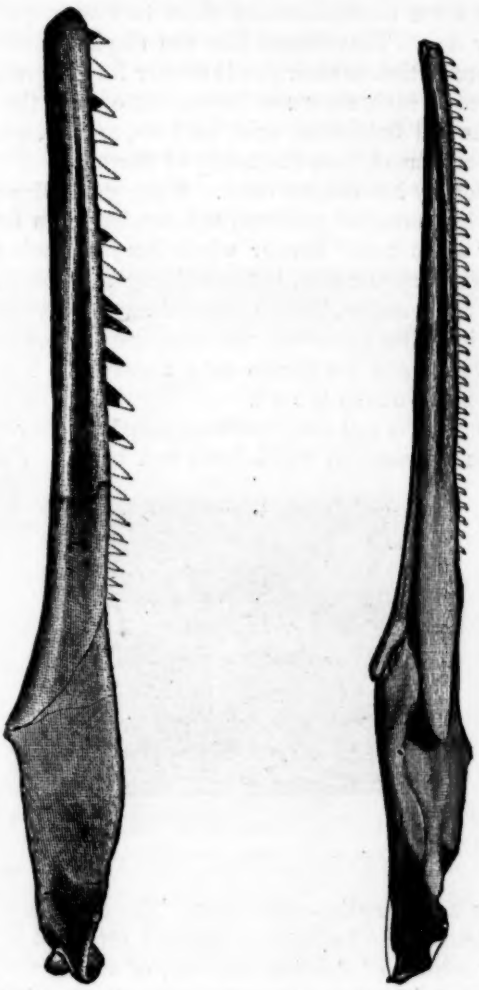


FIG. 4. FIG. 5.

LOWER JAWS OF ANCIENT TOOTHED BIRDS (after Marsh).

Fig. 4: *Ichthyornis dispar*. Twice the natural size. Teeth in distinct sockets. Fig. 5: *Hesperornis regalis*. One half natural size. Teeth set in a groove.

jaws, called mandibles and maxillæ, which move horizontally between upper and under lips. Such insects usually have gizzards to complete the mechanical process. The grasshoppers and others have the gizzard armed with rows of horny teeth. The activity and efficiency of

insect-jaws is very great, as many people have the misfortune to know. From before the time of Pharaoh, the biting insects have been a scourge to the farmer. Their voracity is awful; and, when urged by hunger, few substances can withstand their jaws. In countless hosts they ravage a country, and blast it as with the curse of Jehovah. It is stated that some caterpillars eat three to four times their weight of food every day. That beasts like the elephant and tiger are not voracious in proportion to their size is matter for congratulation. Fortunately, however, such ravenous insects eat only in the larval state; for most moths and butterflies exist on love, and none take any more substantial nourishment than the honey of flowers.

The common fly has minute teeth. Many grubs live within trunks of trees, gnawing immense galleries, and subsisting on the wood. The termites, or "white ants," devour whole houses, leaving only a shell fair to all external appearance, but crumbling at a touch. "At Tonnay-Charente the termites, having gnawed away the props of a dining-room without its being perceived, the flooring collapsed during a party, and the entertainer and his guests sank through." The larva of the giant sirex gnaws burrows in lead.

Teeth of mollusks and articulates are usually horny—that is, hardened skin, like the crust of the lobster and beetle. Sometimes they

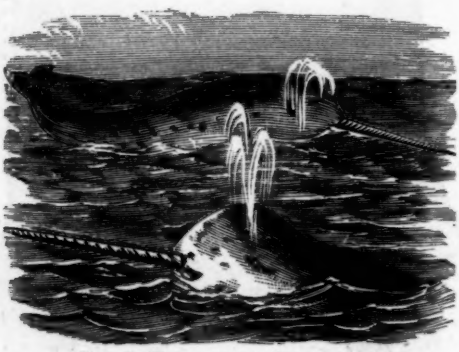


FIG. 6.—NARWHAL, OR SEA-UNICORN.

are calcareous and sometimes siliceous. Those of the vertebrates are complex in structure and substance, and are regarded as the only true teeth. They consist of dentine or ivory, of which there are several kinds. In mammals and the highest reptiles, the dentine is surrounded by a sort of bone called cement; and the surface exposed to wear is capped or otherwise protected by enamel, the hardest of animal tissues. Teeth do not belong to the bony skeleton, but are developed by the lining membrane of the mouth, which, like the lining of the whole food-canal, is only a continuation of the skin. Hence teeth are classed with other skin appendages, as the nails and hair.

The teeth of fishes are extremely various in number, form, struc-

ture, and method of attachment. They are almost entirely used for prehension, as nearly all fishes, like reptiles and birds, do not masticate but gulp down their food as quickly as possible. The exceptions, however, are interesting. Some rays and the cestracion of Australia have the jaws filled with teeth, flattened and joined together like blocks in a pavement, or like mosaic. These are used to crush sea-weed and mollusks. In a former geological age, this was the prevailing form of teeth in the whole order of sharks. The common carp has its teeth on the bones of the pharynx, and hence masticates its food in its throat. For this purpose the food is sent back after being swallowed. Some fishes are toothless, but most fishes have hundreds of teeth, frequently covering all parts of the mouth. The teeth of fishes and of reptiles are shed and replaced indefinitely.

FIG. 7.—SKULLS AND TEETH OF MUSKRAT (*Fiber zibethicus*). Size reduced. 1, cranium with upper incisors overgrown, due to loss of lower incisors; 2 *a*, skull and jaw with normal teeth; 2 *b*, lower incisor removed, to show its great length.

Reptilian teeth present no great variety. Toads, tortoises, turtles, and some lizards are entirely destitute of teeth. Frogs have teeth in the upper jaw. Those of serpents assist in swallowing the huge prey. The poison-fangs of venomous species present a peculiar and complex modification. They are fastened to movable bones which are worked

by the muscles moving the jaw. When the mouth is closed, the fangs lie on the gums; but in opening the mouth they are brought into a striking position. The muscles also press at the same time upon the glands which secrete the venom, and force the latter through a deep channel or canal in the fang.

Some birds of ancient times had true teeth placed in sockets in the jaws; but all modern birds depend wholly on the gizzard for mastication. This is literally a mill. It is formed of powerful muscles, has a horny lining, and pulverizes hard grain and indeed almost any substance by rubbing between the tough walls. To assist the grinding, the grain-eaters swallow gravel, bits of broken glass and crockery, metals, etc., which are pulverized in turn. One would suppose such

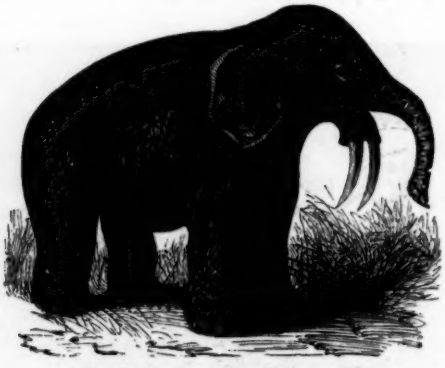


FIG. 8.—DINOTHERIUM GIGANTEUM.

diet would injure the organ; but the tough lining yields without being cut. In birds the gizzard follows the stomach; that is to say, the food is not ground until after it is subjected to the gastric juice. This seems a reversal of the proper order, but the hard grain is more easily pulverized by rubbing after being softened by the solvent fluid. In other animals the gizzard, if a distinct cavity, usually precedes the true stomach. The power of this mill is proportional to the resistance of the food. Thus in flesh-eating birds the gizzard is weak.

Mastication is best exhibited in mammals and is almost entirely by means of teeth. Mammalian teeth are of three kinds: incisors or front cutting teeth; canines, which characterize flesh-eaters; and molars or masticators. They are placed in sockets in the bones, but always in a single row on the outer edge of the jaws, and are never renewed more than once.

The extreme numerical variation of mammalian teeth is found rather strangely in the same group, the order of whales. A river-dolphin of South America has the greatest number, two hundred and twenty-two; while the whalebone whale has no developed teeth, they being replaced with baleen-plates. The narwhal, or sea-unicorn, has, of two

in embryo, but a single tooth developed. This, however, is remarkable as being the longest in the animal kingdom. It is the left upper canine, and except in rare cases possessed by the male alone. Instances are recorded where both teeth were developed. This ivory tusk points directly forward in line with the body, perfectly straight, and sometimes attains the length of ten feet. The rough surface is spirally grooved as if the tusk were twisted. Various unsatisfactory conjectures have been offered regarding the object of this strange development; but, beyond its evident use as a weapon, its purpose is still a mystery.

The whole group of ant-eaters, and the sloths and armadillos, are quite destitute of teeth, on which account they are called edentates. Many of them have no teeth whatever; and when teeth are present

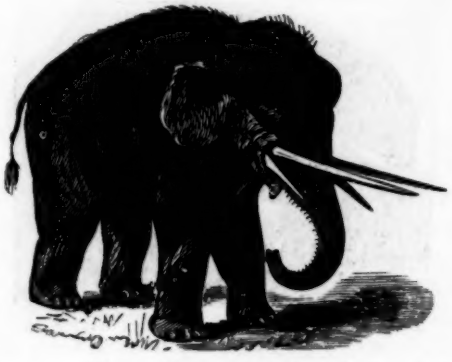


FIG. 9.—MASTODON GIGANTEUS.

they are limited to the back part of the jaws, without enamel and rootless—all of which features help to rank the edentates very low among mammals. In place of teeth, the duck-bill—the lowest of mammals—has four horny plates, two in each jaw.

The average number of mammalian teeth is thirty-two—possessed by man, apes, and ruminants. But, the hog is the happy possessor of the typical number, forty-four; which honor is also shared by the opossum and mole. Man is the only living animal with an unbroken succession of teeth, and having the canines of the same height as the others.

The incisors of rodents are very interesting. They are the only prehensile organs of the gnawing mammals, and are exposed to severe wear. But, as the enamel is thicker and the dentine harder in front, the abrasion constantly produces a chisel-edge admirably fitted for gnawing hard substances. They must, however, be kept of a certain length; and to supply the loss by abrasion they are continually growing out from the base, being supplied by a permanent pulp. Their length in the jaw is great, to insure solidity without actual union with

the bone. The loss of an incisor results in the abnormal lengthening of the opposing one, which may finally interfere with mastication and cause starvation. Ruminants have no incisors in the upper jaw; the elephant has none in the lower jaw, but the tusks are upper incisors. An elephantine mammal of former geological time, the dinotherium, had incisor tusks in the lower jaw, pointing down and backward; while the extinct mastodon had tusks in both jaws.

The canines are intended for seizing and tearing prey and especially characterize carnivorous mammals. They are lacking in rodents and most herbivores, and are never more than four in number. In the apes they are very prominent; those of the gorilla nearly equaling a lion's in size. The tusks of the walrus are upper canines, as also are the terrible tusks of the wild hog. In the Malayan hog the upper

FIG. 10.—BABYROUSSA, OR MALAYAN WILD HOG.

canines, instead of pointing downward, as would seem proper, grow upward through the integuments of the skull and curve backward, sometimes reaching the skull again. Their purpose is obscure. Although possessed in such degree by the male alone, the form precludes their efficient use as weapons. The lower canines also grow to enormous length and are directed outward, forming weapons which make the beast a formidable antagonist.

Herbivorous mammals have the molars flat on the grinding surface, and the enamel and cement disposed in plates and folds perpendicular to this face. Thus by the unequal wear of the tissues the acting surfaces are ridged and admirably adapted for grinding. They form an actual grist-mill, the stones of which never need any "picking." In fruit-eaters the crowns of the teeth are rounded. Insectivorous mammals have the teeth conical and fitting in opposing depressions. Those living on a mixed diet, as man, have the tubercles or cusps somewhat blunt, and suited either for crushing or cutting. In purely carnivorous mammals the molars have sharp edges fitted for cutting meat. They act like chopping-knives, or more accurately like scissors. Quite the only motion of the jaw is up and down, as flesh can not well be ground. Here we have a genuine "hash-mill." The backward and forward

motion of the jaw prevails in the rodents. Other mammals have the lateral motion in a great degree, making three motions. All vertebrates have the jaws opening vertically, while articulates have horizontal jaws, and the sea-urchin has converging jaws.

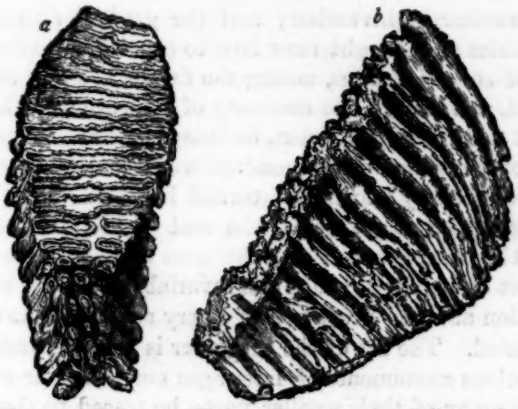


FIG. 11.—MOLAR TOOTH OF MAMMOTH (*Elephas primigenius*): *a*, grinding surface; *b*, side-view.

The harmony and mutual dependence between all parts of an animal's body are not better shown than in the adaptation of the teeth of vertebrates to the kind of food, and their consequent agreement with the habits, structure, and form of the individual. A single tooth frequently reveals the entire character of its possessor. Indeed, no single organ is of greater zoölogical value. Not only does the student of living forms use the teeth as indicative of character and a means of classification, but their superior durability makes them of the very greatest importance in the study of ancient life.

ABOUT CARPENTERS.

BY MAURICE MAURIS.

IT is characteristic of architecture that the further back we look toward the primitive state of man, the more the use of wood prevails over that of stone, brick, and all other building materials, and the more does the importance of carpentry exceed that of masonry. The condition of this art might well be taken as the basis of division between the various stages of the civilization of a country. During the first stage, wood is everywhere the only material used in construction; the second stage is marked by a mixture of wood and ashlar work; while in the third, or highest stage, carpentry yields constantly to masonwork, until it becomes a mere subordinate agent.

We can imagine man in a savage state. "The penalty of Adam's —the seasons' difference"—was full upon him; at first he crept, like the beasts, within groves and hollow trees, or into dark caves and holes dug in the earth; or else he perched himself, like the birds, in nests built with less skill than those of the swallow or the stork. But necessity is the mother of invention; and the gradual sharpening of his obtuse faculties soon taught man how to procure a better shelter. In the dawn of social impulses, noting the fall of the rain and the sweep of the wind, and feeling the necessity of providing for his own security against the wild beasts; next, deriving some rude ideas of stability from the contemplation of the material world and of the structures instinctively erected by animals, he turned his mind to the construction of dwellings which might afford him real protection, and he availed himself of the materials at hand—the trees by which he was surrounded. The art of building, which has invariably been the starting-point of civilization and the precursor of every species of knowledge, was thus originated. The art of the carpenter is thus the earliest of arts; and the glorious monuments of later ages may, in their main outlines, and even in many of their smaller parts, be traced to the rough wood huts which arose in the wild forests and in the midst of lakes during the prehistorical times.

Like Cuvier, who, out of an age-eaten bone, was able to rebuild the skeleton of a whole fish, paleontologists of our day have, from the scanty remains found in the lakes of Europe, deduced almost to a certainty the characteristics of the lacustrine dwellings which formed the abode of man during the neolithic period of the Stone age. The interest awakened by such discoveries has been so great as to render it wholly needless for us to give a description of the house, bridge, and boat building of prehistoric man. The savages of the present age seem to have been providentially left to confirm the truths which paleontology has endeavored to wrench from the bowels of the earth and the depths of the water; they seem to be left as milestones to indicate the road that mankind has passed over, or rather, as Edmond About says, "They are the stragglers in the army of civilization, by the presence of whom we are informed whence the great body started and whither it went." Reliable accounts of travelers bear witness, in fact, to the existence, even at the present day, of certain Asiatic and Polynesian islanders, who still inhabit wood dwellings erected on piles driven into the water, thus perpetuating a custom prevailing in times beyond record. Herodotus has a passage relating to a tribe that dwelt five hundred and twenty years before the Christian era on Lake Prasias, in Thrace, the modern Roumelia, whose modes of life illustrate those of the lake-dwellers. According to this historian, the Pæonians lived upon the lake in dwellings erected on platforms, which were supported by piles and connected with the land by narrow bridges. They were polygamists, and a law directed that, for each wife, three piles

should be added to the structure, thus wisely adding to its security. There was a hut for every family, with a trap-door giving access to the lake beneath. The small children were tied by the foot with a string, lest they should fall into the water.

Hassenfratz took some trouble to ascertain the actual form of the huts of savage tribes of our time. In his book on carpentry he gives thirty-three specimens, of which, however, only sixteen or eighteen were copied from existing habitations, the remainder being derived from detailed descriptions of travelers. The pyramidal form, as the simplest, is that generally adopted by the more barbarous tribes, which fact gives good ground for conjecture that this style of building is the oldest of all. Usually the plan is oblong, though sometimes circular, and the roof is either angular or curved, according as stiff or pliant woods were at hand. In the African *kraals* and similar huts, flexible pieces of wood are bent into a semicircle, and the ends fixed into the ground. Other huts resemble pig-sties, rabbit-bins, and chicken-houses. The Siamese elevate the floor of their cabins some feet above the ground for protection from the damp, and the summer huts of the Kamtchatdales are built on posts and have for an entrance an inclined piece of timber with rough steps, like those in chicken-houses, leading to the roosting-place. This seems to be the primitive idea of building a staircase.

Chinese structures, when compared with those of less advanced nations, are a token of wonderful progress. The Chinese have had regular carpenters from time immemorial, while, among primitive nations, there is no trace of classification of workmen into distinct trades. A species of bamboo is much used by the Chinese; the inner part of this wood being spongy, it is practically a cylinder which does not admit of squaring, but is strong, hard, and durable. The skill of the Chinese carpenters is chiefly demonstrated by their light and elegant bridges, and, if we mistake not, the first idea of suspension-bridges was borrowed from them.

Among no nations of civilized antiquity did carpentry attain so high a development as among the Persians, the Hebrews, and the Phœnicians. With these nations joinery, in the proper acceptation of the word, may be said to have begun, and the progress that this step marked in art is more easily imagined than described. Whatever be the credit accorded to the book of Genesis, it will always remain the most authentic record of the Hebrew nation in Moses's times. The account therein found of the ark is very important in connection with ship-building: if we reflect that the proportions of the ark have been nearly the same as those of modern ship-building, up to the time of the application of iron and steam to navigation, their skill can not but command admiration. From its resemblance to a house, it may also be safely inferred that Hebrew dwellings were divided into stories and rooms and had a sloping roof, which, upon the whole, is essentially the

form of modern houses. The knowledge of the Phœnicians concerning geometry and mechanics, as a matter of course, improved their carpentry to such a degree as to make their workmen sought after even by the Hebrews. To Hiram, King of Tyre, both David and Solomon applied not only for materials, but for the greatest number of carpenters he could spare, when proposing to build the Temple of Jerusalem. If we consider what a large share of work carpentry has in establishing a colony and making it prosper, and, again, to what fame the colonies founded by the Phœnicians all along the Mediterranean coast arose, their prominence in this art will be still better proved. A carpenter of Samos, by the name of Mandrocles, perhaps the oldest carpenter whose name has found a place in history, built a bridge on the Bosporus, which, in a few days, afforded passage to Darius and his seven hundred thousand men, when on his expedition against the Scythians.

No documents, to our knowledge, remain that concern the carpentry of the Egyptians. Perhaps, owing to the peculiar conditions of the land, masonry prevailed in Egypt at a very early stage of their civilization; the Pyramids and the temples of Memphis prove, however, better than tongue or pen, what was their knowledge of the art under consideration; those gigantic monuments presuppose the existence of the most powerful machinery. Expressing contempt for any man who by his work contributed, however slightly, to the public welfare, was among the Egyptians, as is known, an infraction of the law, and punishable in consequence. In the case of a young carpenter who had made but a few school implements and had been ill-spoken of, his rights to the public respect were thus solemnly acknowledged by the Magus who sat as judge: "The carpenter who makes school implements accomplishes more toward the improvement of his fellow men than many kings have done."

Vitruvius has speculated at length respecting the form of the early huts in Greece: it appears that they were originally cuneiform; then rectangular, with flat roofs, the boards being well connected and nailed to the posts; later on, the roof became angular, and the hut assumed a shape from which the general outlines of the Doric temple were derived. So enthusiastically was this peculiarly framed roof in former times admired, that even Cicero was betrayed into the unphilosophical remark that, if a temple were to be erected in heaven, where no rain falls, it would be becoming to crown it with a pediment roof. It is hardly needful to explain how the posts were ultimately deprived of their bark, rounded, smoothed, raised on stones and similarly crowned at the summit end, and, to prevent splitting, bound with ligatures at both extremities. "As large trunks," Eny says, "were sometimes difficult to obtain, we note as one of the consequences the petrified bundle-pillar of reeds or sticks tied together at the top and bottom. These most probably suggested the idea of flutes; and the superin-

cumbent pressure, causing a slight swelling in the center, gave rise to the entasis of the column."

With the Greeks and the Romans, carpentry, as well as its sister arts, made great progress, by being applied to war purposes. Military carpenters became the bulwarks of warfare; they were the strategists and pioneers of the time. Be the siege of Troy either history or fable, Homer's accounts prove beyond doubt that the Greeks possessed war-engines contrived with unusual ingenuity: the wooden horse that caused the fall of Troy, and the Argonauts' ship, taking them even as symbols, bear witness to this fact. To any one who, in his boyhood, has perused Cæsar's "Commentaries," the description of the famous bridge thrown by his legions over the Rhine must be still so familiar as to render it useless for us to dwell any longer on this detail. It is evident, however, that in Greece and Rome carpentry, as applied to building, yielded early to masonry. Wood was too soft a material for those sturdy citizens to struggle against; their pride and wealth were too great, their taste too refined, not to prefer the durable and majestic appearance of stone and marble to the perishable littleness of a vegetable matter. Yet, as an art subservient to masonry, carpentry was always up to the standard of the former. But the existence of a perfect system of levers and pulleys, in a word, of all kinds of machinery, may explain the locomotion of those monoliths which are seen standing to this day, like giants among pygmies, at enormous distances from their place of origin. The English are perplexed as to the best means of transporting Cleopatra's Needle to England: Roman carpenters would have deemed it an every-day job!

Had Cæsar taken the same trouble in describing the dwellings of the Gauls as he has respecting their fortifications, war-engines, and ships, an exact idea of their domestic carpentry, at that distant period, would be easily formed. But this not being the case, we can give but very scanty information on the subject. At any rate, the twenty cities of the Biturians, burned down by order of Vercingetorix—the last of the Gauls—were built of wood. In the remote parts of the country which had scarcely any dealings with the invaders, so much is still left of Gallic traditions that, according to Paul Lacroix, it is more than a simple presumption to state that they resembled in shape the rectangular, straw-roofed huts of the modern peasants of northern France, and of the mountaineers of Auvergne. On the other hand, in the merchant cities of the Mediterranean, carpentry was developed in a manner corresponding to their wealth and extravagance. In the interior, numbers of houses were a mixture of wood and stone work, with colonnades and porticoes, which we would liken somewhat to the cottages so common nowadays in this country. The Gauls, too, excelled in military carpentry. When Cæsar threw his legions on their soil, every serious obstacle which he met was due to carpenters. They directed and executed all defense-works; their cities, like Alise, Bourges, and

Namour, had been fortified by carpenters, by means of palisades, and when the Romans attempted to take them by storm, supposing them to be an easy prey, the war-engines of those carpenters hurled them more than once from the top of their ramparts, where they died, at last, like true heroes, for freedom and independence.

The most astonishing progress made by carpentry in ancient times is, in our estimation, that shown by Holland. There man had struggled for ages against the invading waves for the ownership of a land which, in the end, he succeeded in making his own. "Twice a day," the oldest legends tell us, "the ocean extended its empire over the shore with terrible rage, and rose as high as the level of the wooden houses built on immense piles of wood, at considerable distance inland, so that they seemed to float above the water, and their trembling inhabitants could not move around except in boats." This gives an idea how the dwellings of the Hollanders were built, and is an unquestionable token of their skill, as the work of building houses on the sand, supported on piers, and capable of resisting the enormous tides that visit the country, was by no means an easy task; yet they performed still more surprising works: they laid the foundations of those dikes that are reckoned among the greatest works of any description ever accomplished by man.

As has been stated above, in Italy, since the time when Rome was at the height of its glory, masonry, in domestic building, had taken the place of carpentry. But, with the downfall of the empire, when, society being upset, no one could trust in the morrow, and the execution of works which demanded peace and length of time to be accomplished became impossible, carpentry recovered its power; again it controlled architecture and its sister arts, and again it supplied the needs of the barbarians in the savage manner of which it had been formerly divested by civilization. As truly as an epoch of the past can be revived, the primeval ages were called to new life, and with them the primitive systems of construction. Nor could it be otherwise: the savage hordes who now overran Europe felt, thought, acted, and lived as the hordes who had preceded them centuries before. Fortunately, their destructive work did not last long, nor could it extinguish entirely the light that civilization had cast over the land. The conquering races passed away, leaving after them only their good elements—the industrial and agricultural classes—which settled and amalgamated with the indigenes. Carpentry was then called upon to supply new wants. The new religion had grown and spread over the world; it needed oratories and temples; it needed belfries in order that the scattered faithful might hear from afar the consoling sounds which called them to worship. Primitive Christians were neither rich enough, nor sure enough of meeting with tolerance, to undertake the erection of stone buildings. Carpentry supplied their moderate needs. The oldest basilicas were all of wood in the style of that of St. Martin on

the ramparts of Rouen, where Meroveus and Brunehilde took refuge to escape the wrath of Queen Fredegonda, and the remains of which were till lately extant. "It was a wooden church," says Augustin Thierry, "the slender frame of which, with its columns formed of several trunks of trees tied together, and its arcades necessarily angular (owing to the difficulty of centering with the materials at hand), that furnished, in all appearance, the type of the ogive or Gothic style which has since played so prominent a part in architecture."

According as the industrial and agricultural colonies led by St. Benedict spread, carpentry enlivened the wilderness of central and northern Europe by constructing those monasteries around which large communities grouped, thus rendering them greater commercial than religious centers. To the carpenters of St. Benedict the establishment of the first manufactories is due as well as the introduction of water-mills, which, though known before, were yet so rare in the fifth century as to make one of them, erected on the river Indre, France, by Ursus, Bishop of Cahors, seem the marvel of the time, and so excite the covetousness of Alaric, King of the Visigoths.

History, always ready to register any deed of princes and courtiers, has rarely preserved any record of the martyrs of labor. In documents discovered and examined with much patience and labor by recent historians, mention is, however, made of a carpenter, by the name of Modestus, who in his time exercised great influence upon the course of events. He lived in Soissons, and, though a plain, unlearned man, he appreciated and honored virtue whenever and wherever he found it. When Gregory, Bishop of Tours, was accused of treason to Queen Fredegonda, by Subdeacon Rikulph, her favorite, and when he was brought to Soissons for trial, Modestus indignantly appealed to the people to defend the saintly bishop, and placed himself at their head. But Rikulph, backed by the Queen's army, caused the poor carpenter to be taken, whipped, tortured, chained, and thrown into a dungeon. Modestus, however, broke his chains and escaped. His escape seemed a miracle, and, as such, it could not fail to affect and embolden the multitude. A conflict was about to ensue, but Modestus deprecated violence and checked the movement. He rushed into the court, by his eloquent pleading persuaded the judges of the bishop's innocence, and exposed Rikulph's iniquity. Gregory was acquitted, but the carpenter, later on, paid with his blood for his love of justice and his opposition to the Queen's favorite.

When cremation of corpses ceased to be a general custom, certain nations intrusted carpenters with the duty of preparing the last dwelling of man. It is not long since quite a number of tombs, perhaps eleven or twelve centuries old, were discovered on the banks of the Danube. They were hollowed out of the trunks of trees, in the form of primeval canoes, to symbolize, perhaps, the last journey of man to unknown regions. We have read somewhere that the tree selected

was generally the favorite one of the deceased. How poetical is the destiny of that tree receiving in its bosom the man to whom it had formerly afforded shelter and, perhaps, nourishment!

Between the sixth and the eighth centuries, owing to the increasing activity of the Church in multiplying establishments of all kinds, and to the spreading of agriculture and industry, as well as to the unceasing wars, carpentry had widely enlarged its province. Thus it is not surprising that division of labor was applied to carpentry; and bridge-makers, or "pontiffs," as they were called, after the Latin fashion, builders, joiners, ship-builders and military carpenters were recognized as distinct trades, nor could one division intrude upon the duties of the others.

Though the middle ages are generally estimated as an epoch of retrogression in art, carpentry improved. Its military department was naturally perfected by the unrelenting wars. In these an enormous number of workmen found employment. The battering-rams, the wheeled turrets, and all war-engines received further development. In the ninth century many castles were exclusively made of wood, which proved so strong as to increase the desolation of the invaded countries, for invaders set fire to those they could not take. Such was, in 886, during the siege of Paris by the Normans, the fate of the castle rising on the spot on which the "Châtelet" was afterward built. It was defended by only twelve men; yet the Normans tried again and again in vain to take it, until, tired of their useless assaults, they destroyed it by fire. Byzantine and Gothic architecture, too, becoming bolder, afforded carpentry the opportunity of acquiring an incontestable artistic value; and, if it lost somewhat of its importance in reference to the creation of the great body of a building, it gained ground in the accessories. The interiors of temples and palaces were stocked with furniture; the wooden ceilings were set into compartments of elaborate carvings; the doors divided into panels and ornaments; the cold nakedness of the kalsomined walls was concealed by panels of oak and chestnut, set off in modillions and figures in bas-relief, separated by columns supporting entwined arches. A variety of chests was manufactured; the holy-lofts of churches, as well as the halls of private and public dwellings, were furnished with benches and chairs, previously very rarely seen. All this was, then, the work of carpenters; it was not until later that wood-carvers and cabinet-makers formed a distinct branch of the trade. "Capable, as they were, of accomplishing many more things than the carpenters of our day," Paul Lacroix says, "and being at the same time geometers, constructors, and modelers, the carpenters of the middle ages must be considered rather as artists than as artisans."

About the end of the twelfth century, France having grown tired of war, the throng of pontiffs and carpenters, formerly connected with the armies of the Carlovingian kings, no longer found employment.

Hundreds of those craftsmen, forced by want, swelled the companies of marauders known in history as the "Routiers," "Cottereaux," and "Brabançons." Owing to this reënforcement, their plunderings grew to frightful proportions.

Between the years 1180 and 1182, a pious carpenter of Puy, named Durand, in an outburst of honest and patriotic indignation at sight of the disorders committed by his fellow tradesmen, declared that he had been intrusted by the Lord with the mission of restoring peace. Such was the enthusiasm aroused by his preaching a crusade against the Brabançons, the most terrible of those adventurers, that in a short time he gathered around him a powerful army which were called the "Brothers of the Peace." The Brabançons were exterminated, the other companies having disbanded on learning the successes of the "Pacifics." Durand was hailed as a hero, and the savior of his country. But fanaticism and ambition engendered excess; the Brothers of the Peace became a cause of dread to the community; and France, which, during this moral ebullition, had rejected a part of its impure elements, now cast aside the others, by dispersing the chiefs of the Brotherhood of the Pacifics. Durand, as was often the case under similar circumstances, met with death by order of the powerful lords, for the safety of whom he had worked.

With the organization of commons, carpenters organized themselves in various brotherhoods. Every community was independent, had its peculiar privileges, laws, traditions, and usages. An officer called "Master Carpenter of the King" presided over each one of the French brotherhoods. He was as a brake put to the wheels of the organization by the shy despotism of the monarch. The Church, too, of course, interfered and gave them the character of religious associations. According to the statutes of the Paris brotherhood, carpenters were bound not to work from nine o'clock on Saturday night till Monday morning. The brothers were apprentices or masters. The apprenticeship lasted four years, in the first of which the apprentice was forced to pay his master from one to three farthings per diem. A carpenter could not be compelled to work in the night, except for the royal family and the Bishop of Paris. Every corporation had jurors who were selected among masters having at least ten years' experience, and whose business was to settle, as referees, all questions arising in business transactions. As the choice of materials was of paramount importance for the security of the community at large, it was the jurors' duty to examine all wood before it could be used; the use of wood upon which the jurors had not thought fit to put their seal entailed heavy fines and even the suspension of the transgressor. The purchases of wood made in advance did not bind the carpenter, if the jurors failed to find it satisfactory; on the arrival of the merchandise, too, the purchaser could not take possession of the whole cargo, if his brother-tradesmen were not provided with sufficient materials to go on with work in hand.

Strange as it may appear, this provision was very wise, as it placed public utility above personal interest and prevented monopoly. They had a chapel of their own, where, besides religious affairs, all the business concerning the brotherhood was transacted. There the apprentice aspiring to mastership underwent the practical and theoretical examination on which his fate depended; the work executed by him on the occasion was consecrated to the patron saint of the community.

In connection with the bridge-makers there are some details that we can not afford to omit. These carpenters, during the middle ages, were a kind of nomad tribe, who traveled in companies and pitched their tents wherever their work was required; bridges were built at their risk, and they had no claim to payment until their work had withstood the test of the winter floods. Originally they came from northern Italy, but in the twelth century a similar association was formed in Germany, which shortly monopolized the trade in northern Europe.

During the thirteenth century, masonry and blacksmithing continued to invade the sphere that carpentry had previously appropriated to itself; the reign of carpenters was over, yet the share of work remaining in their hands was sufficient to enable them to keep step with the artistic and industrial movement of the time. Gunpowder being invented, carpentry, for some time, enlarged its province. The first guns were made of wood, strengthened by bands of iron; new engines were also invented; the reader can imagine who were the first gunners, the first pyrotechnists, and the managers of the *Grète*, as well as of all similar new contrivances.

People acquainted with history will readily understand that a great change must have been operated in carpentry by the civilization of the fourteenth century. In obedience to the laws of evolution and progress that rule the moral as well as the physical world, some provinces of this art were absorbed by superior arts and sciences: some passed under the control of sister arts, others expanded themselves and gained new ground. The carpenter whose bodily strength was overbalanced by the power of his mind was hailed as an engineer or as an architect; the average carpenter remained workman and carried out the ideas of his superiors. This was apparently a fall; yet carpenters made another step forward in the path of progress. The frequent festivals afforded them opportunity to display new talents and skill; descriptions of the festivals of the time may be found in any historical book, which resemble more the tales of the "Arabian Nights" than accounts of real events. During the reign of Louis XIV., a new building—the theatre—was erected; it was made almost entirely of wood, and though in a wholly different order of ideas, carpenters seemed to be inspired in working out the new construction, according to the lofty conceptions by which church-building had been formerly distinguished. Stage carpenters too, accomplished wonders; the illusion was so complete as to make some one say that "stage-carpenters lived an ideal life." Undoubt-

edly, in a time in which plays dealt so much with the supernatural, playwriters would have done nothing, had they not found full support in carpenters of superior capacity. The name of William Van Schepdael, a carpenter who, assisted by a mason, Henry Vits, covered an arm of the Seine, at Paris, with a vault some thousand yards long, supported by only eighteen hundred wooden pillars, in order to have the space utilized for building purposes, is unknown even to the majority of his fellow tradesmen, but his work remains, and is, even at present, one of the industrial glories of Paris.

In order to avoid repetitions, in connection with the history of carpentry in England, it will be sufficient to state that, begun as anywhere else, it kept step with the development of the country, yet we feel bound particularly to mention English ship-building. The geographical position of the land, which naturally determines its inhabitants' tastes for seafaring, explains the progress of ship-building there. Although the fleets of Pisa, Genoa, and Venice, of Spain and Portugal, had, at different times, won great fame, England eclipsed them all.

It was the privilege of the eighteenth and the nineteenth centuries to fix carpentry on a thorough scientific basis. The works of Monge, his lessons of descriptive geometry ; the profound works of Prony, on statics, hydrostatics, and hydrodynamics ; the researches and discoveries of Lalande, Inghirami, and many others formed a wealth of scientific principles from the application of which carpentry naturally derived unspeakable advantage. Regular schools were founded, among which that of Monge ranks first. Thence have come Krafft, Hassenfratz, Morisot, and scores of carpenters who raised the art to the level of a science.

In several States of the Union the three stages of civilization alluded to in the beginning of our sketch are shown in a striking manner ; there, on the same farm, the log-cabin, the frame-building and the brick house are still frequently seen ; what has been in Europe the work of centuries, here has been that of a generation, and yet it represents an improvement on former work. It is a peculiarity of American frame-buildings to have all the improvements of the best-built stone houses in Europe. Americans have done with carpentry what was before deemed to be a privilege of masonry and iron exclusively. If we dared express our opinion, we would say that, as regards architecture, carpentry is here ahead of masonry. In comparing the pleasant frame-houses of the American farmers with the half-ruined brick dwellings of the French and Italian peasants (who are, however, the most comfortable of European country people), it is to be doubted whether masonry is really indicative of a more advanced civilization. Were we not to make great allowance for the peculiar circumstances in which this country has developed its moral and material faculties, we would solve the question against the generally accepted theory, and proclaim carpentry still the greatest agent of progress. Carpentry

in America has not yielded to masonry; even in the erection of brick or stone houses, the former has a greater share of work, the latter doing scarcely anything beyond building the outside walls. In American brick or stone houses, about twenty-five times more wood than in European is used. This may have its evils, wood being subject to ignition and not being naturally so endurable as other materials; but it will not take long for Americans to invent some process by means of which wood may be rendered incombustible, and as solid as stone; something in this direction, we believe, has been done already. The bold centering of domes and the slender elevation of steeples on skeletons of wood, as carried in this country, command the attention of foreigners; there are a dash and lightness in those works that bespeak the skill of American carpenters. The mechanical performances of "Sardanapalus" and other plays can not be overlooked in an article referring to carpentry. Nor can we omit to record that American ship-building compares favorably with that of any nation, the English included. Yet all this becomes a trifle if we consider American wood bridges. The Schuylkill bridge, built by Wernwag at the beginning of this century at Philadelphia—a suspension-bridge, 340 feet long—can not but be considered a marvel of art. This bridge would not yield save under a weight of 1,275 pounds per square inch of the lower chord! During the civil war the constructions of the Federal troops astonished the world; to the rapidity with which new bridges were built in a truly artistic and scientific manner, and to the skill of their architects, engineers, and carpenters is due, in great part, the success of the Northern forces.

Carpenters appear to us as the vanguard of progress, the initiators of all movement toward the supply of mankind's first wants. However incomplete, we trust that our sketch will be deemed suggestive enough to show that their history is worthy of being diffused through the medium of a popular publication.

THE AVAILABILITY OF ENERGY.

By W. D. MILLER, B.A.

IT follows, as a direct consequence of the most usual definition of matter as "the vehicle of energy," and is also arrived at from experience, that energy never does and never can manifest itself except in connection with matter. And, although we could readily conceive of, and in fact see many instances of, matter without energy, yet no person of sound intelligence, or, as said Newton, "no one with a competent faculty of thinking," could for a moment entertain the idea of energy without matter; and we naturally suspect that anything

which is so dependent upon another for its existence, as it were, will, in some way or other, mold itself to suit the form and convenience of the other. It thus becomes a question of primary importance as to how energy is connected with and dependent upon matter, and as to how its form and availability are influenced by its connections.

That the same amounts of different kinds of energy, or even of different forms of the same kind, are vastly different in their effects, is a thing of every-day experience. A mass raised above the earth's surface possesses in consequence a certain amount of energy, in virtue of which it can do work; but if it be allowed to fall to the ground under the influence of the earth's attraction, then, although the amount of energy on the earth is neither increased nor diminished, it may be absolutely impossible to gain any work from it. In this instance energy of position is at first transformed into energy of motion, but the moment the mass strikes the ground all motion, as far as we are able to discover, is gone; but we know that the motion of the mass as a whole has only been transformed into motion of the particles among each other, and of the particles of the body on which the mass impinges, constituting the phenomenon of matter commonly called heat. The first two states are available as sources of mechanical energy, but in the third state the energy is scattered into an infinite number of infinitely small energies, as it were, and, in the case of small masses at least, is lost forever as far as doing work is concerned; and so much energy is let down from a high to a low class, and the whole energy of the universe is rendered less available by a corresponding amount.

But not only do equal quantities of energies of different kinds manifest themselves so very differently, but the same is true as to equal amounts of the same kind. A boxer may receive a blow from his antagonist which may stagger him, and perhaps throw him off his balance, but yet do him no permanent injury; while a rifle-ball with half the energy, though it might not disturb his equilibrium, would in all probability inflict instant death. Any number of examples of this kind might be given to show to what an extent the form which a given amount of energy assumes and the constancy of its effects are dependent upon the matter with which it is associated.

Now, the transformability of energy is a measure of its availability, and, in fact, energy is of use to us only and solely because it may be and is constantly transformed (consequently, whatever terms determine its transformability, the same hold good for the determination of its availability).

Since all forms of energy are essentially kinetic or potential, or the energy of heat-motion, it is sufficient if we examine the laws with regard to these.

A body is said to possess *potential* energy when in virtue of its position it *can* do work. A raised weight possesses potential energy, which, by a simple contrivance, may be converted into work; a bent

bow and a wound-up spring possess energy of position, because of the separation of their molecules, which we may avail ourselves of by allowing them to fall back into their natural positions.

If a body be allowed to fall, it necessarily loses the energy which it had in virtue of its position as it approaches the ground, but at the same rate it gains a different kind proportional in amount to the space passed through, and consequently to the square of the velocity. In the case of a projectile, or pendulum-bob, there is a gradual transformation from kinetic to potential energy during the ascent, and a re-transformation during the descent. If we spend work in raising a weight, bending a bow, or winding up a spring, that work is spent in laying up stores of energy which we may avail ourselves of at any future time. But if in performing any of these actions we encounter resistance, as in the case of friction, part of the work is spent in overcoming it; and, when we endeavor to get back the energy we put forth, we find that we fail by as much as was spent in overcoming the friction. The energy so spent was long a puzzle to scientific minds, and was believed to be absolutely destroyed, until the experiments of Rumford and Davy fully demonstrated that the work spent in overcoming friction was transformed into *heat*—a form of kinetic energy, it is true, but of such an inferior class as to have entirely escaped the notice of the shrewdest observers. It is, in general, a very easy matter to transform the whole of the potential or kinetic energy of a body into heat; but it becomes quite a different undertaking when we propose to reconvert the heat into either of the other forms.

Carnot was the first who made any progress in the investigation of the subject of the transformation of heat into mechanical energy. His manner of operating was strikingly original and one of great merit, and has assisted wonderfully in the development of this part of science since his time. He established two new and distinct propositions in connection with his method:

1. That we have no right to reason on what has taken place in any series of operations till the working substance has been brought back to its initial state, nor to assign any relation between heat and work by such reasoning.

2. That a reversible engine is the most perfect engine possible. And, consequently, if we possessed a reversible engine, and a condenser absolutely deprived of heat, we could convert the whole of the heat from the boiler into mechanical energy. But since it is impossible to obtain an absolutely cold condenser, there is always a large fraction lost in attempting to convert heat into mechanical energy. Sir W. Thomson, working from the principle laid down by Carnot, found that the heat taken in by a perfect engine is to that given out as the absolute temperature of the boiler is to that of the condenser. He also, carrying the process further, devised a correct proof of Carnot's second proposition, based upon the axiom that "*it is impossible, by means of inani-*

mate material agency, to derive mechanical effect from any portion of matter, by cooling it below the temperature of the coldest of the surrounding bodies."

With the present physical constitution of matter this is true, so far as we are yet able to penetrate at least; but since its constitution might have been such as to render such an axiom null, we purpose to inquire into the physical properties of matter which admit of such an enunciation, and the results which in consequence must be predicted for the present universe.

Let us consider a hot spherical body, whose energy we wish to communicate to another equal sphere, absolutely cold, and suppose for a moment that they have a thin outside crust absolutely impermeable to heat, and that the mass of each sphere is concentrated in a single little ball, to whose motion the heat is due, the ball in the cold sphere will of course lie still at the bottom, while the other is flying about at an inconceivable rate; if, now, the two spheres be brought into contact, and an opening be made between them, in a very short time the ball will undoubtedly pass from the hot to the cold sphere, and thus all the energy will be transferred at once, and, if a movable partition were inserted in the passage, all the heat-energy might be *transformed* into mechanical energy.

If we suppose two balls, instead of one, in each sphere, as soon as *one* passes from the hot to the cold, it will share its motion with the two already there, and one or more of them may pass back before the second has escaped, and thus at once the relations are rendered more complex, and the chance for availing ourselves of all the energy is diminished. If, now, the number of balls becomes infinite, or if we reduce our imaginary spheres to two real spheres, and substitute molecules for balls, then $1 : \infty$ is not an exaggeration of the chance of all the energy being in *one* of the spheres at any time in the future; on the other hand, the continual tendency is to, and the ultimate result is, absolute equality in temperature.

Clerk Maxwell has made the supposition of a vessel full of air, divided into two portions, A and B, by a division in which there is a small hole; and a being, *who can see the molecules*, opens and closes this hole so as to allow only the swifter molecules to pass from A to B, and only the slower ones from B to A. He will thus, without the expenditure of work, raise the temperature of B and lower that of A, in contradiction to the second law of thermo-dynamics.

By the above mode of reasoning, together with the conclusions drawn from our experience of bodies consisting of an immense number of molecules, the result has been arrived at that *the availability of a given amount of energy is determined on a physical basis, and is dependent on the infinite number of particles of which every tangible mass must be composed.*

The instance cited by Professor Maxwell is only "applicable to the

more delicate observations and experiments, which we may suppose made by one who can perceive and handle the individual molecules which we deal with only in large masses."

In the *theory* of dynamics we say that action and reaction are equal; and if a body be arrested in the course of any motion, and sent back on its path with exactly the same velocity, it will retrace its path, and at any point of that path it will have exactly the same velocity and the same energy as when it passed through it in the opposite direction. But, *practically*, we are unable to realize such a law, because of the resistances we meet with in friction, electric induction, etc., so that any series of actions taking place in nature is not a reversible one, or the mechanical energy spent can never be wholly restored to its primitive condition. But as a reversible process is the only one which can maintain itself for all time, it follows that our earth is gradually lowering its energy from high to lower classes; the ultimate form to which all must be reduced being that which has its source *not in the position or motion of masses, but of molecules.*

If this process of transformation were not continually going on, our fires would cease to burn, our machines stop working, and all animal and vegetable life would perish. "The whole of active life is simply transformations of energy." Wherever two particles of matter fall together, whenever a drop of rain falls to the earth, whenever an atom of carbon combines with an atom of oxygen in the furnace, we must look upon it as so much energy let down, the greater part of which is dissipated and lost to human good. But it may easily be seen that this degradation of energy is not restricted to the earth alone, for among natural forces we recognize—

1. The energy of fuel, under which we include the energy of food, as being simply the fuel of an animated machine.
2. The energy of a head of water.
3. The natural motions of air and water.
4. The tides and trade-winds.
5. The very inconsiderable mechanical effect derived from the combustion of native sulphur, and from meteoric sources. The first three are wholly due to the sun, and the fourth in part, so that by far the greater amount of our available energy is derived from the sun. "For it is he who separates the carbon from the oxygen of the carbonic acid and enables them to combine again, whether in the furnace of the steam-engine or in the animal body." It is he who sets the air in motion, and raises up the water whose fall is to turn the wheels of our mills. We are thus receiving a constant supply of energy from the sun, and his must be diminished in a corresponding degree.

But, not content with what we receive, we dig down into the bowels of the earth and exhaust our own. There can be no doubt as to the final result to which this universal tendency points. Long after the earth has become uninhabitable, it may be, the kinetic energy of

every planet of our system being frittered away into heat by friction on the ethereal medium, they shall find their way, one by one, into the sun's mass, thus giving him the energy by which he will work on for long ages after they are defunct; while he, in his turn, with all his accumulated mass, will precipitate himself into the center of some larger system: and this process will go on till, after various oscillations throughout, perhaps, infinite ages, the whole material universe is accumulated in a single mass, which will then go on radiating its heat into space till it becomes a black, cold, and lifeless mass.

This universal tendency of energy to concentrate, or rather to scatter itself into the least available form, is simply what has been called "*the dissipation of energy*," and may be said to be the complement of *the availability of energy*, and, like it, finds its basis and explanation in that molecular constitution of the material universe which renders it impossible for any amount of energy, which has once distributed itself among the immense number of molecules in any body, ever, of itself, to rise again to a more tangible and available condition.

THE INFECTIOUS AND CONTAGIOUS DISEASES OF CHILDREN.*

By Dr. DELPECH.

THE teacher or director of the school is urged to give immediate personal attention to any child in the school who may appear ill, or who complains of feeling unwell. In such a case the teacher should specially note the presence of one or more of the following signs:

1. Increased temperature of the child's body, discovered by the teacher placing his hand upon the sick child's skin, particularly on the chest, armpit, face, or forehead.

2. Quickening of the pulse, as measured by the aid of a watch, together with hardness of beat.

3. Shivering. Increased or exaggerated sweating, not being the after-result of exercise, etc.

4. Great thirst, with loss of appetite.

5. Tongue more or less white; dry, or red.

6. A flushed or pallid face.

7. Increased or diminished brilliancy of the eye.

8. General weariness and indisposition; sense of fatigue, with aching in the loins; headache; drowsiness or excitement; delirium.

* Instructions regarding the early symptoms of the infectious and contagious diseases of children, prepared by Dr. Delpech for the use of teachers of infant and elementary schools in the Department of the Seine. Abridged and translated by J. Lawrence Hamilton, M. R. C. S.

The majority of the above-named symptoms will almost invariably indicate the presence of a febrile state.

Any child kept at home away from school for a week or more by its parents should, before returning to its school, bring a certificate of health, signed by a duly qualified medical practitioner.

Infectious Febrile Diseases.—*Small-pox* is rarely found in those schools where vaccination is enforced, as the majority of vaccinated children have not yet lost the protective influence of primary vaccination. Whenever possible, the teacher should have all the children over ten years revaccinated, especially in times of epidemic small-pox. The popular assertion, that, during epidemics of small-pox, revaccination tends further to develop small-pox, is absolutely false.

Small-pox sets in with fever, vomiting, and pains in the loins. After not less than two days, but most frequently on the third day of the illness, there appears—commencing on the face—an eruption of raised spots, more or less numerous, which pass later into pimples or pustules, having a depressed or navel-like center. These spots terminate in scabs, which should have completely disappeared before the child is allowed to return to school. Before readmission to the school the child should have had two or three baths.

Chicken-pox is a mild disease, occasionally preceded by fever. It is characterized by successive crops of *blebs*, preceded by red-colored spots, each new crop being apt to appear toward evening, and is generally accompanied with some accession of slight fever. Chicken-pox is characterized by pea-sized *blebs*, or blisters, filled with a transparent watery liquid, which soon becomes thick, muddy, or bloody, and terminates with scabs. Where the spots on the body are neither numerous nor well marked, the eruption is invariably observed among the hair of the head.

Measles is ushered in with general indisposition, fever, sneezing, weeping, and red eyes, loud noisy cough; occasionally there may be bleeding from the nose and passing diarrhœa. After three or four days' illness, sometimes sooner, an eruption shows itself, first on the chin and face in small, irregular rose-red spots, slightly elevated, which soon spread over the surface of the body, leaving more or less pale, irregular patches of skin unattacked. The complaint is highly contagious. Children with measles, when *kept at home*, and not exposed to the chance of catching cold, generally do well.

Scarlet fever commences with extreme general indisposition, high fever, a dry, burning skin, pains about the throat, and vomiting. Generally toward the end of the first day's illness, sometimes even at the very outset, a child, but a few minutes before in apparent good health, presents itself with a raspberry-red blush or rash, which may either cover the body completely or else appear here and there in patches. The face, the interior of the thighs, the groins, and the neighborhood of the joints are favored situations for the rash. At first glance the

eruption looks uniform, but a closer examination discloses innumerable round points, some of which are more pointed and higher than their neighbors, and often run into minute bladders about the size of a pin's-head.

Sometimes the disease is singularly mild; sometimes exceedingly virulent. Sometimes it is so fugacious that its presence is not suspected until the skin begins to peel, a process notably observed on the hands and feet. Frequently the joints, particularly the wrists, suffer pains analogous to those of rheumatism. Scarlet fever is an extremely contagious disease; and while, after ten days' isolation and the use of a bath at the close, a child convalescent from measles may be allowed to associate with others, not less than six weeks' isolation is required to exhaust the communicability of a case of scarlet fever.

Mumps may come on suddenly, or else be preceded by a few days of general indisposition, which now and then amounts to high fever. A feeling of stiffness about the jaws is soon followed by swelling, often very bulky, and more or less tense. The swelling is apt to extend either at the back of the lower jaw or underneath it. The swelling contains no fluid: dental pain is absent. Generally first one side of the jaw is attacked and then the other; it is rare for both sides to suffer simultaneously. Not uncommonly similiar swellings burst out in other localities of the body, the genital organs being most liable to seizure.

Ulcerative stomatitis is a contagious disease. Its invasion may be preceded by general indisposition, usually unattended with fever. Grayish bleeding ulcers, tending to spread in extent and depth, attack the edge of the gums, the inner side of the cheeks and lips, and the roof of the hard and soft palates, accompanied with an extremely fetid breath.

Diphtheritic sore-throat or croup is eminently contagious. Its approach is insidious, often commencing with some difficulty in swallowing and slight hoarseness. Possibly the glands at the back of the angle of the jaw swell, which in serious cases extends to the neighboring structures of the neck. At other times these symptoms occur subsequent to a swelling about the nostrils, with more or less copious discharge, indicating that the nasal membranes have been seized prior to those in the throat. Cough, if any, is faint and muffled; the voice is hoarse and smothered.

With a spoon press down the child's tongue, and note if there be any appearance about the tonsils and the soft palate of a skin or leather-like membrane, which may be grayish or whitish, or even blackened by vitiated blood. This false membrane, which characterizes the disease, is prone to spread over the neighboring parts, notably reaching downward into the windpipe. This diphtheritic croup must not be confounded with false or spasmodic croup.

In *false* croup the child has generally been perfectly well during

the day preceding the night on which it suddenly wakes up all at once ill with alarming signs of threatening suffocation, attended with loud, clamorous coughing and a clear voice. Here no false membrane is present in the throat, nor are the glands about the jaw swollen. False croup is generally mild, and it is not contagious.

Dysentery may be contagious. It is distinguished by a frequent, sometimes a continual, desire to seek relief in the closet, where in spite even of severe straining the child succeeds in passing only a little slime or mucus, often colored by small quantities of blood. General indisposition and colicky pains in the belly soon compel the child with dysentery to leave the school. To stop infection, no child suffering with dysentery should be allowed to use the general school water or other closet. Dysentery is not to be confounded with diarrhœa, where there are more or less frequent liquid motions.

Typhoid fever is infectious, and is apt to set in or to sneak in with ill-defined signs. For some days the child may have lost its appetite and its general energy, it is fatigued and "done up." Then the fever is next ushered in with great pain, noises and confusion in the head; the hearing becomes obtuse; giddiness occurs, with great difficulty to keep any upright position. There is often bleeding from the nose generally followed up by colicky pains in and swelling of the belly associated with some diarrhœa. The skin is dry, parched and hot; the tongue fouled, with red tip and sides. However, the child before this has been compelled by its state of indisposition to cease attending the school.

Whooping-cough is eminently contagious. The child may be noticed to have had during one or more weeks occasional but violent fits of coughing, which are most frequent during the night. If no complication be present, there is practically no cough between these spasmodic attacks. Usually a short feeling of general indisposition precedes the attack, during which the child in vain struggles to suppress the cough about to burst, when all at once the trunk and frame are subjected to a violent series of successive throbs almost threatening suffocation. At this epoch a few deep drawings-in of the breath are followed by a whistling and almost convulsive inspiration, which may again be succeeded by boisterous coughing. Then in most cases, after a brief moment's repose, a second but a less severe and a shorter onslaught than the first is noticed. Lastly, the fit is terminated by the child's partly spitting and partly swallowing some thick mucus, often at the same time vomiting up any matter present in the stomach.

The time occupied by these seizures to their termination by expectoration varies from sixteen seconds to a couple of minutes.

Owing to the grave and fatal complications often associated even with apparently mild cases of whooping-cough, most especially in very young children, immediate isolation of the sufferer from its schoolfellows is necessary.

OPHTHALMIA.—Both catarrhal and purulent ophthalmia are highly contagious at all ages, but especially in very young children, and the last-named disease may cause the loss of one or both eyes.

The eyes and their lids become red, swollen, and bathed with a discharge often more or less offensive.

CONTAGIOUS PARASITIC DISEASES.—*Itch* is characterized by the appearance of minute transparent vesicles, which occasion the most lively itching, particularly at night-time. The spaces between the toes and fingers, and the wrists, are most liable to invasion. The child's frequent scratching soon converts the rash into scabs, in which condition the disease will frequently first be noticed by the teacher.

The itch is caused by an insect (*Acarus scabei* or *Sarcoptes*) which is nocturnal in its habits and movements. Though highly contagious, the itch can be cured in a few hours.

Crusted ringworm, or *Tinea favosa*, is caused by a vegetable parasite frequenting the scalp, although it may visit other parts of the body which are covered with hair or down. The hair becomes thin and fragile, with loss of its original color; then follow irregular, unequal, puckered, crust-like yellowish scabs, which may be single or may cover the entire scalp. The scabby flakes in drying and dying crumble to minute fragments, and as dust propagate and disseminate the disease. Itching being frequent in scalp ring-worm, the child's scratching increases the destruction and pulverization of the scab, and thus increases the chances of contagion to others.

The heads of such children as suffer from the disease have a peculiar fetid odor resembling that of a cat's urine. Till quite cured, every child suffering from *favus* should be separated from its schoolfellows, and only be readmitted on presenting a proper medical certificate.

Common ringworm, or *Tinea tonsurans*, is very contagious, making itself manifest by the hair of the head becoming thinner, more fragile, less colored than the surrounding hairs. The affected hairs are apt to turn reddish or ashy-gray; they seem as if evenly and artificially clipped off at a distance of say $\frac{1}{14}$ to $\frac{1}{8}$ of an inch above the level of the outer layer of the skin. The surface of the patches is rough, irregular, shaggy, covered with a grayish, scurfy powder of a slightly bluish tinge. The diseased places may be one or more in number; the form is circular, varying in size from that of a silver florin to a crown-piece. By the fusing together of several of such parasitically affected localities the greater portion of the scalp may become affected.

Ringworm with Baldness of Scalp (*Tinea decalvans*).—This contagious complaint declares itself by the presence of defined patches naked of all traces of hair having a glistening ivory whiteness not unlike a scar without depression. Their size varies from that of a silver threepenny-piece upward.

Previous to the loss of hair there may have been considerable itch-

ing. The eyelids and other parts of the body covered with hair or down may also suffer from the vegetable parasite causing the disease (*Microsporon Audouin*). In children and adults with thick hair this disease may remain long undetected.—*Practitioner.*

THE RATE OF ANIMAL DEVELOPMENT.

By J. W. SLATER.

"Consider young ducks."

ONE of the attempts which have been made to establish the existence of a "great gulf" between man and beast may be pronounced exceptionally curious as an instance alike of careless and defective observation and of rash conclusions. That by such arguments men of eminence could really mislead themselves, and succeed for a length of time in misleading the outside public, is deeply humiliating. Professor St. George Mivart suggests* that a book should be written on the "stupidity of animals." We are far from denying that such a work would be useful; but, should the needful companion volume on the "stupidity of man" make its appearance in due course, it might not unfittingly open with the reasoning we are about to quote.

To begin, then: the slow bodily development of the human infant and its prolonged helplessness are matters far too familiar to require proof, or even illustration. No less familiar and universally admitted is the rapidity with which foals, calves, lambs, kids, chickens, and ducklings acquire the use of their limbs and other organs. These facts could not fail to come under the notice even of the most careless observers. But, who could have imagined that the said facts would be, without further inquiry, at once seized hold of as a theme for stilted declamation, and be elevated to the rank of a fundamental distinction between man and the lower animals? Yet this strange error has actually been committed, not merely by men of words, like Addison, Paley, and Whewell—which is surely sad enough—but even by a man of things, like Sir Humphry Davy. The great chemist attempts to show that man does not use his limbs instinctively, like other animals. Says he:

"Man is so constituted that his muscles acquire their power by habit,† but in the colt and the chicken the limbs are formed with the power of motion, and these animals walk as soon as they have quitted the womb or the egg.

* "Lessons from Nature."

† To speak of acquiring a power by habit is scarcely rational. The power must exist before the habit can be formed.

"*Physicus.* I think I have observed that birds learn to fly and acquire the use of their wings by continued efforts in the same manner as a child does that of his limbs.

"*Ornither.* I can not agree with you. Young birds can not fly as soon as they are hatched, because they have no wing-feathers; but, as soon as these are developed, and even before they are perfectly strong, they use their wings, fly, and quit the nest without any education from their parents."*

Very similar assertions are found in a laborious attempt made by the late Professor Whewell† to set aside the palpable fact that man, like every other animal, has an instinctive—or we might perhaps better say an hereditary—knowledge of the functions of his voluntary organs.

Said the Professor: "The child learns to distinguish forms and positions by a repeated and incessant use of his hands and eyes; he learns to walk, to run, and to leap by slow and laborious degrees; he distinguishes one man from another and one animal from another only after repeated mistakes. Nor can we conceive this to be otherwise. How should the child know at once what muscles he is to exert that he may stand and not fall, till he has often tried? How should he learn to direct his attention to the differences of different faces and persons till he is roused by some memory, or hope which implies memory? It seems to me as if the sensations could not, without considerable practice, be rightly referred to ideas of space, force, resemblance, and the like. Yet that which thus appears impossible is, in fact, done by animals. The lamb, almost immediately after its birth, follows its mother, accommodating the action of its muscles to the form of the ground. The chick just emerged from the shell picks up a minute insect, directing its beak with the greatest accuracy. Even the human infant seeks the breast and exerts its muscles in sucking almost as soon as it is born."

So, after all, "that which thus appears impossible" is, in fact, done not by "animals" only, but by man also! The concession contained in the last sentence is simply fatal to what has gone before. To be consistent the learned Professor ought by all means to have asserted that an infant learns to suck only "by slow and laborious degrees," and after its sensations have been rightly referred to appropriate "ideas." It would scarcely be a more unwarrantable assumption than those he has indulged in abundantly in the course of his argument.

In the same vein as Davy and Whewell, teleologists and natural theologians, when enlarging upon the marvels of instinct, have seldom failed to "trot out" the colt, the calf, or the lamb, to invite our consideration to the chickens and the "young ducks," and to erect upon the precocity of these creatures—as compared with the tedious devel-

* Collected "Works," vol. ix. "Salmonia," p. 105.

† "Philosophy of the Inductive Sciences," ii., p. 616.

opment of our own species—a fancied wall of demarkation between man and beast. Had they been really actuated by a scientific spirit, they would have felt it their bounden duty to ascertain whether *all* the lower animals were, in contrast to man, able to use their limbs soon after their birth. Had they done so, they might have met with evidence similar to what is thus given by an actual observer* in describing an infant orang-outang which had come into his possession: "The Mias, like a very young baby, lying on its back quite helpless, rolling lazily from side to side, stretching out his hands into the air, wishing to grasp something, but hardly able to guide its fingers to any definite object, and when dissatisfied opening wide its almost toothless mouth, and expressing its wants by an almost infantile scream. . . . When I had had it for about a month it began to exhibit some signs of learning to run alone. When laid upon the floor it would push itself along by its legs, or roll over, and thus make an unwieldy progression. When lying in the box it would lift itself up to the edge into almost an erect position, and once or twice succeeded in tumbling over."

Thus we see that, the nearer brutes approach to man in their structure, the more gradual is their development. The process which in the colt and the lamb is contracted so as to escape observation is here shown at very considerable length. That the child, especially in the higher races of mankind, makes a still more gradual progress, is plainly a mere question of degree.

The young ape which Mr. Wallace observed was, beyond all reasonable dispute, acquiring the use of its limbs precisely in the same manner as a human child. If the latter learns, by slow and laborious degrees, what muscles he must exert in order to effect any desired movement, so does the young ape. If the child can not judge of the position and distance of objects, till it has by considerable practice learned to refer its sensations to appropriate "ideas," the same must be said of the young Mias. But, if the young apes, and, indeed, all other young animals, inherit from their forefathers a latent knowledge of the use of their organs, which is called into activity as soon as their muscular and nervous systems are sufficiently developed, the same holds good of the human infant.

Of course, it would be unfair to demand of such men as Professor Whewell that, before theorizing and dogmatizing, they should go forth to the forests of Borneo in search of facts. As for Davy, his splendid achievements in chemistry may cover his failure in biology. But surely every man in Europe, though he may never have met with infant apes, must have seen how kittens, when beginning to walk, totter, stagger, and roll over, just like young children; how they pat at, and endeavor to touch, objects beyond their reach; and how, even after the forelegs have gained a considerable degree of firmness and obey volition, the hinder extremities remain feeble, and are often for

* A. R. Wallace, "Malay Archipelago," p. 45.

a time trailed helplessly along. Thus, then, we see that in the mammalia, instead of man standing alone, sharply contrasted to the rest of the class, he merely occupies one extremity of a series toward the other end of which stand our much-talked-of friends the lamb and the foal, while the carnivorous animals and the apes occupy intermediate positions. Some very plain reasons why this should be the case will follow in due course.

But what are the facts concerning birds? Are they all able, as soon as hatched, to direct the beak with perfect accuracy, to select suitable nourishment, and to flutter about awaiting merely the growth of their wing-feathers before they can take flight? Davy's "Ornither" must have been either a willful sophist or a most egregious goose. Had he been an accurate and conscientious observer, he must have been aware that what he predicates of birds in general is true, in any sense, merely of the Gallinæ, Grallæ, Anseres, and Struthiones, and assuredly not of the Passeres, Picariæ, Columbæ, Psittaci, and Raptores. Did any of the authors to whom we have been referring, before indulging in platitudes on young ducks, ever take the trouble to "consider" young hawks, young thrushes, or young canaries? Had they done so they would have seen that such nestlings, instead of being able to "direct the beak with the greatest accuracy," can merely sit in the nest with open mouth waiting to be fed! A young canary, so far from being able to stand or walk, seldom fails to break its legs if startled and induced by fright to attempt leaving the nest. Such facts as these are known to every bird-fancier—nay, we might say to every rustic youth, who has ever robbed a nest and has attempted to bring up the callow young by hand. They are not known, it appears, to men of erudition. It was, we think, the Prime Minister of Gustavus Adolphus, of Sweden, who said to his son, "Thou knowest not with how little wisdom the world is governed." In like manner, and even more truth, it might be said that we know not with how little accurate thorough knowledge books are compiled, the world is misinstructed, and imposing reputations are built up.

We do not demand original observation from Professor Whewell. Every one knows that the possessors of inherited wealth are apt to despise the man who has acquired a fortune by his own exertions. But there is a class of men—more numerous, we fear, in England than in any other civilized country—who, with a still more unjustifiable prejudice, contemn all knowledge that has not been derived from books, and scorn original research and discovery. Still it is strange that none of these writers should have met with the following observation from Gilbert White:* "On the 5th of July, 1775, I again untiled part of the roof over the nest of a swift. The squab young we brought down and placed upon the grass-plot, where they tumbled about and were as helpless as a new-born child. When we contemplated their

* "Natural History of Selborne," Letter XXI.

naked bodies, their unwieldy, disproportionate abdomina, and their heads too heavy for their necks to support, we could not but marvel."

Davy and Whewell might, further, have found in Erasmus Darwin's "Zoönomia"* some remarks on the different stages of maturity which animals of different species have reached when they are first brought into the world. The author uses these very words: "The chicks of the pheasant and the partridge have more perfect plumage, more perfect eyes, and greater aptitude for walking, than the callow nestlings of the dove or the wren. It is only necessary to show the first their food and teach them how to pick, while the latter for days obtrude a gaping mouth." Would it have been too much trouble for a man of such extensive reading as Professor Whewell to have run his eyes over the passage above quoted? Being, moreover, a German scholar—at least to the extent of an occasional mistranslation from the language—the Professor might have read that Lorenz Oken divided the class Birds into two main subdivisions, nest-sitters and nest-quitters (*nest-hocker und nest-flüchter*), according as when hatched they remain helpless in the nest, or are at once able to run about and seek food for themselves.

Davy, by the mouth of "Ornither," gives a very lame explanation of the fact that the majority of birds can not fly as soon as hatched. Before they can take flight they have to await not alone the growth of their wing-feathers, but the simultaneous development of the muscles. The Raptores, Passeres, etc., are, as we have already seen, unable to walk as well as fly. Does this inability depend upon the want of feathers? The fact that parent-birds educate their young is clearly established by the interesting observations of Dr. C. Abbott.†

In the case of birds of prey the process of education is somewhat prolonged, even after leaving the nest. It is thought by many that Deuteronomy xxxii., v. 11, is a description of the manner in which eagles train their young to fly; "stirring up" the nest, i. e., shaking and disturbing it so as to compel the nestlings to leave their cradle; "fluttering" over them "and bearing them on her wings"—that is to say, following and intercepting their downward movement, and aiding them to reascend.

Thus we see that the condition of the young of the lower animals is, after all, analogous to that of the human infant. The child, indeed, is still slower in learning to walk than the kitten or the young ape, not because he has to learn in a different manner, but because the development of his muscles and joints is much more gradual; because his head is relatively heavier; because he has to support himself on one pair of limbs only, thus rendering his base much narrower and his center of gravity higher from the ground; and because, as we have already pointed out in the case of the kitten, the hinder extremities gain strength more slowly than the anterior.

* Vol. i., pp. 187–194. † "Quarterly Journal of Science," vol. vi., p. 361.

Surely, therefore, the helplessness of the human infant can no longer be regarded as an exceptional phenomenon, and all conclusions based upon it by rhetoricians may be safely dismissed to dream-land, whence they came.—*Journal of Science.*

ARTIFICIAL DIAMONDS.

THE world of science and the world of fashion are so far removed from each other that they are seldom stirred by the same event, but the production of artificial diamonds has lately startled both these distant realms.

Mr. Hannay, of Glasgow, has recently exhibited before the Royal Society certain crystals which are no accidental productions, but direct results of a process conceived for a definite end. These have been examined by analysts like Professors Maskelyne, Roscoe, and Dewar, and declared to exhibit all the physical and chemical properties of true diamonds.

Mr. Hannay's gems are very small; but whether he will hereafter succeed in producing large stones, and what effect success of this kind would have on the value of the diamond, we do not propose to inquire. This is a question which concerns the world of fashion alone; the world of science is interested in asking by what means the crystallization of carbon has at length been accomplished.

Every one is acquainted with the various forms of the substance called carbon. It constitutes a large proportion of all animal and vegetable structures, and we know it best in an impure condition as coke or charcoal; but it occurs crystallized, and in a state of purity, in two very different forms, viz., diamond and plumbago, or black-lead.

Those bodies which resist all attempts of the chemist to resolve them into simpler forms of matter are called elements, and among the vast number of substances composing our earth some sixty-four, which are for the most part metals, are simple bodies; of these carbon is one.

Almost every substance which is capable of existing in the solid state assumes, under favorable conditions, a distinct geometrical figure. This power which bodies possess of taking on definite forms is called crystallization, and its most beautiful examples are found among natural minerals, the results of exceedingly slow changes occurring in the substance within the earth. Artificial crystals may be obtained from solutions, by fusion, and in the passage of bodies from the gaseous to the solid condition. Thus crystals of common salt are formed by the evaporation of brine; many metals, as iron and bismuth, crystallize on cooling after being melted; and the vapors of some substances, like iodine, for example, deposit crystals in the act of condensation.

Every body possesses its own distinct crystalline form; every crystal is a geometrical figure, usually bounded by plane surfaces having angles of constant value, and the science of crystallography teaches us to distinguish substances by the measurement of these angles. It is invariably found that artificial crystals which have been deposited slowly and quietly surpass in size, regularity, and beauty those of more rapid formation; hence it is conjectured that natural minerals owe their great perfection to very gradual deposition in the rocks within which they are found.

Under different conditions the same substance sometimes assumes two crystalline forms, of which somewhat uncommon phenomenon carbon furnishes an example by crystallizing now into diamond, and now into graphite, or plumbago.

Although found in every quarter of the globe, the diamond is the rarest as it is the hardest known mineral. It occurs exclusively among gold-bearing rocks, or sands derived from gold-bearing rocks, and among strata which, though originally soft, shaly deposits of sand or mud, have been "metamorphosed," as it is called, into hard crystalline schists. It was once supposed by geologists that the metamorphic rocks were deposited in their existing crystalline form from a boiling ocean enveloping the still heated globe; but it is now known that these formations were originally deposited as mud or sand, and have been transmuted into schists by the influence of subterranean heat acting under great pressure, through lengthened periods of time, and aided by thermal water or steam permeating the porous rocks and giving rise to various chemical decompositions and new combinations within them. The diamond probably originates, like coal or mineral oil, from the gradual decomposition of vegetable or animal matter; we may therefore regard the brilliants which we prize in the drawing-room as having been slowly elaborated from carbonaceous matter furnished by some dead fish, or rotting plant, originally buried in the mud of an inconceivably ancient palæozoic shore.

It will now be seen that, in order to produce the diamond artificially, some means must first be devised whereby the element carbon, which will dissolve in no liquid and vaporize in no flame, can be rendered soluble or gaseous, from either of which conditions it might then probably be recovered in a crystalline form, as happens in the case of other bodies.

Mr. Hannay's attempts to crystallize carbon originated from a research of a very different character. Water, as we all know, vaporizes at a heat of 212° Fahr., and in the same way every liquid has its "boiling-point," or temperature at which it ceases to be a fluid and becomes a gas. Little is known about the condition of matter immediately beyond the "critical point," as the moment of passage from the liquid to the gaseous state is called; and while investigating this subject it occurred to Mr. Hannay that some insight might be gained into a state

of things then so obscure as to be thought hopeless, by dissolving in the liquid under examination some solid substance which fused at a temperature much above the critical point of the fluid.

Sulphur, for example, melts at 111° Fahr., and is soluble in carbon dioxide, a liquid whose boiling-point is 42°. When such a solution was vaporized it was found that the sulphur was not deposited, but remained diffused in the atmosphere of dioxide vapor; or, in other words, the sulphur was dissolved in the gas. If the side of a tube containing such a gaseous solution of sulphur is approached by a red-hot iron, the part next the source of heat becomes coated with a crystalline deposit, which redissolves into the gas on the removal of the heat. In the course of his experiments on the solubility of solids in gases Mr. Hannay further noticed that many bodies, such as alumina and silica, which, like carbon, are insoluble in water, dissolved to a considerable extent in "water-gas," or water at the critical point when it is neither a true liquid nor a true gas. This fact suggested to him that a solvent might even be found for the hitherto insoluble element, carbon; and, as gaseous solutions were found to yield crystalline solids in almost every case upon the withdrawal or dilution of the solvent gas, it was hoped that, from such a gaseous solution of carbon, crystals of diamond might be obtained.

After a large number of experiments, however, it was found that neither charcoal, lampblack, nor black-lead would dissolve in the most probable solvents when these were brought to their critical points, and a new road out of the difficulty had accordingly to be sought.

Chemists have long known that what is called the "nascent" state of matter is one very favorable to chemical combination. Thus nitrogen, for example, refuses to combine with hydrogen, but, if these two substances are simultaneously liberated from some previous combination, they unite at the moment of birth with the utmost ease. Bearing this in mind, it was ascertained that, when a gas containing both carbon and hydrogen is heated under pressure in presence of a metal, the hydrogen is attracted by the metal and the carbon left free.

Mr. Hannay attacked this nascent carbon with many gaseous solvents, and it is his triumph to have found what he sought. In doing so, he has removed a reproach of long standing from the science of chemistry; for, whereas the larger part of that science is occupied with the chemistry of carbon and its compounds, this element has never previously been either dissolved or vaporized by man.

What the solvent is, we are not at present definitely told; we only know that it is some nitrogen compound, probably a cyanide; but the process is quite intelligible in the absence of this information, while its products are open to the examination of experts.

A hydrocarbon vapor, such as petroleum, is decomposed at a high temperature and under great pressure. As the hydrogen and carbon part company, the former is absorbed, while the latter, being nascent,

dissolves in a gaseous solvent, from which solution of carbon crystals are then obtained, just as table-salt is produced by the evaporation of brine, and these crystals are diamond.

The temperature at which the dissociation of the hydrocarbon is effected must be very high, and the pressure enormous, so that the great difficulty of the process lies in the construction of an inclosing vessel strong enough to withstand the combination of heat and disruptive force. Coiled tubes of wrought iron, of half an inch bore and four inches external diameter, have been torn open in nine cases out of ten.

The mineralogical tests which demonstrate the genuineness of diamond are as follows: It must scratch topaz and sapphire, its angles must be those of a regular octahedron, it must burn without leaving any residue, and it must exert little or no action on polarized light. Professor Maskelyne, of the British Museum, has already stated in the "Times" that Mr. Hannay's crystals satisfy all these tests. They score topaz and sapphire easily and deeply; the angle of their cleavage-faces, which could not be measured with great accuracy on account of the minuteness of the gems, is 70° 29′, while that of the diamond is 70° 30′. Particles ignited on platinum glow and disappear exactly as the gem would do, and they are very nearly inert in polarized light.

It is not long since science rejected the claims of another Glasgow investigator to the artificial production of crystalline carbon, and it is somewhat singular that Mr. Hannay's successful solution of this great chemical problem should have followed so quickly upon Mr. McTear's failure.

That the diamonds in this case are real there is now no question; and it is quite possible that, just as experience has taught chemists how to produce large and perfect crystals from solutions which under ordinary treatment yield only small and imperfect specimens, so Mr. Hannay may by and by succeed in making diamonds as big as the Koh-i-noor or the Regent.

We learn, however, from the investigator's own statement, that up to the present time it has cost him five pounds to produce five shillings' worth of diamond; but, even if the world of fashion is destined to deplore the degradation of its cherished gem, we may be sure that, long after some new toy has satisfied society for its loss, the crystallization of carbon will possess for the greater world of science the same kind of interest as clings around the discovery of oxygen by Priestley, or the demonstration of magneto-electricity by Michael Faraday.—*Belgravia.*

SKETCH OF PROFESSOR OTTO WILHELM STRUVE.

By Professor SIMON NEWCOMB.

OTTO WILHELM STRUVE, now Director of the Pulkowa Observatory, was born at Dorpat, Russia, May 7, 1819. His father was Dr. Wilhelm Struve, Director of the Dorpat Observatory, and one of the most distinguished of European astronomers. While the son Otto was still a youth, the father imbued the Emperor Nicholas, whose confidence he enjoyed in a high degree, with the notion of erecting the greatest observatory in the world, and thus adding to the luster of his reign and associating his name with the history of science. Thus arose the great Observatory of Pulkowa, some twelve miles south of St. Petersburg, which has sometimes been called the astronomical capital of the world. The work of erecting the observatory, constructing the instruments, and getting the whole established and at work, occupied the years from 1835 to 1840. On the removal of the family to the new establishment, Otto, although only a little over twenty years of age, commenced work as an assistant to his father. His first serious work was an examination of all the stars in the northern heavens, made with the great refractor, in order to detect new double stars. The result was a catalogue of many hundred double stars, all before unknown, and many very close and difficult. The subject of double stars was one which seemed to belong especially to the Struve family, their observations and measurements having been at Dorpat the great work of the father, who thus became preëminent in this branch of research. His "Mensuræ Micrometricæ" is one of the standard astronomical works of the century, a book whose magnificent proportions correspond to the labor expended in its preparation. The next considerable work of the son, and one which has been of enduring value, was a determination of the constant of precession, or, to speak more popularly, of the annual amount of motion of the equinox among the stars. His result has been the accepted standard for thirty years, and the work won the gold medal of the Royal Astronomical Society in 1850.

In 1847 and 1848 he made a series of observations of the satellites of Uranus and Neptune with the great equatorial. His observations of the satellites of Neptune gave the first mass of that planet, which was received with much confidence, but the very unfavorable situation of the planet rendered the result more erroneous than was at first supposed. It has since been proved that the observations made about the same time by Bond, at the Harvard Observatory, gave a result much nearer the truth. While on this work he commenced a search for the inner satellites of Uranus, which had been suspected by Sir William Herschel, but have since been proved not to exist. He succeeded, however, in making several observations of what he at the time supposed to be a new inner satellite, but did not succeed in getting a suf-

ficient number to establish the orbit. The existence of two inner satellites has since been established, and it is probable that Struve's observations were sometimes on one of them and sometimes on the other.

The field covered by Struve's subsequent labors is so large and his papers so numerous that it is not easy to give any untechnical account of his works. He has determined the parallax of several stars, made a careful series of observations on the rings of Saturn, made several journeys to observe solar eclipses, and had general charge of the geodetic operations in the Russian Empire. His greatest recent work has been a continuation of the work of his father on double stars. In 1878 the observations of this class, which he had been making for thirty-five years, were all collected and published in the ninth volume of the "Pulkowa Observations."

In 1862 he succeeded his father as Director of the Pulkowa Observatory. Since that time his energies have been as much occupied with the general direction of the establishment as with independent scientific work. His family has been distinguished by the managing capacity and diplomatic skill of its members, some of whom hold high positions in the civil and diplomatic service of the Government. The subject of our sketch is, in this respect, not inferior to his relatives; and the great efficiency which the observatory has attained under his direction is due as much to his cautious temper, good sense, and judicious management, as to his scientific ability.

The last enterprise undertaken by Struve is of special interest to us. For many years the great telescope at Pulkowa, and its brother instrument at Cambridge, both of fifteen inches aperture, were the largest successful refractors in the world. With the construction of the eighteen-inch telescope for Chicago in 1862, the introduction of larger instruments was inaugurated and continued until the great Washington telescope left that at Pulkowa far behind. This was so far contrary to the ideas of the Pulkowa Observatory that about a year ago the Russian Government authorized Struve to negotiate for the construction of a larger refractor than any yet made. The most difficult and delicate matter was the objective, and, after a visit to the principal European workshops, he determined to come to America for the purpose of conferring with Alvan Clark and Sons, and inspecting their *chef-d'œuvre* at Washington. On arriving here in August last he spent several weeks in visiting friends and institutions. At the Saratoga meeting of the American Association for the Advancement of Science, he had an opportunity of making the acquaintance of many of our scientists. The result of his visit to Cambridge was the completion of a contract with the Clarks for a thirty-inch object-glass, which, it is hoped, may be completed within two years if the glass disks can be procured from the makers of optical glass. The mounting of the telescope is to be made by the Repsolds at Hamburg. Having executed his mission, he sailed for his home on September 13, 1879.

EDITOR'S TABLE.

SOCIOLOGY AND THEOLOGY AT YALE COLLEGE.

SOME weeks ago an attempt was made to get up a public sensation out of a reported disagreement in the faculty of Yale College, concerning the teaching of sociology. It was alleged that a conflict had arisen between President Porter and Professor Sumner of the chair of Social Science, in regard to the use as a text-book of Spencer's "Study of Sociology" — a conflict in which the faculty participated, and which might lead to difficulty. Professor Sumner was interviewed, and said it was an old affair, and had been greatly exaggerated; and he hoped that the press would not disquiet itself by working up a discussion of the subject which could do no good to anybody. This was, of course, the signal of a general outbreak; both the secular and the religious journals "going in" with extraordinary unction. Though much interested in the matter, we acted upon the hint of Professor Sumner, and refrained from any remark in the May "Monthly." But the occasion has been used in such a way that some further comment is needful.

It was a wise and an appropriate thing on the part of the authorities of Yale College to establish a professorship for the teaching of social science. The subject is one of growing public importance in all civilized countries, and it is of transcendent interest in this country, where everybody takes so deep an interest in the administration of public affairs. The step was, moreover, imperatively demanded by the progress of knowledge. No intelligent man will deny that social order is based upon natural laws, and exemplifies cause and effect. Social phenomena may be analyzed and classified, and reduced to general expressions or principles, like the other phenomena of Nature. Notwithstanding the apparent chaos of politics, and the discords of legislation, there is nevertheless an underlying regularity in the action of social forces which makes rational politics and legislation possible. Laws are bad or good because there is a constitution of society by which their goodness or badness is determined. It is no longer a question that these social laws shall be worked out as an independent body of science; and this has been already so far accomplished as to lead to valuable practical results, and make it in the highest degree expedient that our eminent institutions of learning should recognize the subject, and enter upon the duty of teaching what is known of it, and of contributing to its further development.

In creating this chair, therefore, Yale College was only conforming to the intellectual requirements of the time; but it was nevertheless a courageous proceeding, for which the institution is to be honored. There is no mistaking the significance of the term *social science*. It implies that human society is a part of Nature to be studied by observation and induction, like the other parts of Nature, and to be pursued in conformity with established scientific method. That method is occupied with the determination of facts and those orderly relations of facts which are expressed as generalizations. As in astronomy or in botany so in sociology, the inquirer has to observe and compare phenomena throughout the whole field, so as to formulate the great activities that are displayed in each sphere, and thus arrive at a connected and comprehensive body of natural laws which

make up the truths of the science. It is perfectly well known that the history of all the sciences shows that in their early stages one of the most formidable tasks of the investigator has been to get rid of the mass of irrational and superstitious beliefs by which the subjects have been overlaid and obscured. Social science is no exception, and in its present formative stage it presents precisely the same difficulties that other sciences have encountered, except that the errors and prejudices are here older, more inveterate, and deeply rooted than in any of the former spheres of scientific inquiry. In physics and chemistry the phenomena dealt with have been fully surrendered to the experimentalist and the reasoner, and there is no longer any interference with him in pushing his conclusions to the farthest limit. But sociology has not reached this fortunate stage. Its investigation is interfered with and impeded by theologians on religious grounds.

We are not at liberty to suppose that the intelligent authorities of Yale College were ignorant of what they were doing when they formally recognized that human society is to be studied in future by the method which has created all the other sciences, and made provision for its teaching in this manner. They knew that the first allegiance of the man of science is to truth as it is determined by processes of reason, and that he is bound to make no terms with preconceived erroneous opinions. That the trustees understood this and acted accordingly, is sufficiently shown by their selection of a professor to fill the new chair of Political Economy and Social Science. They could easily have chosen a facile man for perfunctory work, who would have occupied himself in expounding the miscellaneous matters that now pass current with the public under the name of "social science." But they sought and obtained a thoroughgoing student of the subject, a man of intellectual force and independence, who would give character to the position, and reflect honor upon the college, by his own original contributions to the science committed to his care. That among the considerable number of men who compose the governing body of Yale College—a majority of them clergymen, as we are told—there would have been some more narrow-minded than others, who would be disposed to interfere with the Professor's work and hamper his teaching, was perhaps inevitable; but the liberality and good faith of the institution were virtually pledged to maintain the rights of science in the liberty of its official representative.

Professor Sumner adopted as his text-book Spencer's "Study of Sociology," to be used by the senior class, consisting of young men from twenty to twenty-three years of age, of mature mind, and who have for years had the benefit of Yale College teaching. He adopted the book because it was the only one to be had at all suited to his purpose. It is an introduction to social science by its ablest living investigator. Profoundly impressed with the difficulties of the study in the present state of knowledge, with the misconceptions that are formed of it, and the causes of erroneous thinking in regard to it, Spencer deviated from his regular line of work to make this useful preparatory volume for those who propose to devote themselves to the general inquiry. He explained, in a succession of chapters, how men's judgments are liable to be warped in considering social questions by their habits of thought and their preconceived ideas. One of these chapters was entitled "The Theological Bias," and we are informed that this was considered by some of the faculty so objectionable as to render the volume unfit to be put into the hands of the Yale seniors.

Now, it is to be remembered that Yale College was committed, through the action of its authorities, to the

honest teaching of social principles by the method of science. The object of the students was to gain true ideas of the nature and organization of human society. Nothing, surely, could be more pertinent, or necessary, than for them to be put upon their guard against sources of error in considering the subject. If there is a bias from theological influences that is calculated to vitiate or pervert the judgment upon social questions, what could be more important than that it should be pointed out? In dealing with society from a scientific point of view, Mr. Spencer had to consider it in its widest relations, or as manifested in varying grades, by all races of men upon the earth. In all forms of society religious systems play a leading part, but these systems are diverse and numberless. Mr. Spencer, therefore, drew his illustrations of the distorting influence of theological beliefs upon views of society from different quarters. Mohammedans and Feejeeans, Catholic and Protestant Christians, are cited to exemplify the common tendencies of theological doctrine to obscure the mental vision and prejudice opinion. He shows, moreover, with equal force, how the anti-theological bias may produce, and has produced, the same perverting effects.

The difference in the points of view of the theologian and the scientist comes out here sharply. Science inquires into the laws of phenomena; social science into the laws of social phenomena. As societies have developed, religious systems have also grown up as a part of the general phenomena of social growth. Social science is concerned with religion as a universal fact of human nature, which gives rise to universal social effects—it deals, in short, with the natural laws of universal religious phenomena. With these views theology has no sympathy. It is scornfully and passionately rejected by the religious devotee. His position is that there is one religion that is absolutely true, and that all other religions are absolutely false, and any notion of treating them all alike is rejected with horror. And the one religion that is true, being a supernatural system, is not to be studied as a natural phenomenon, or by the method of science. The devout mind thus recoils at the very fundamental conception of social science, which it regards as the offspring of infidelity and atheism.

To this source of prejudice Mr. Spencer devoted a chapter in his book, and how necessary it was is now abundantly apparent. The religious press has raised a storm of denunciation against the sociologist and all his books, and the professor, faculty, and college that have had anything to do with them. Religious prejudices are stimulated to their utmost by the *odium theologicum*. The "Study of Sociology" is cursed as a book of atheism, and the school that uses it is condemned as a propagator of infidelity. That stanch exponent of the spirit of orthodoxy, the "New York Observer," makes up a sharp issue between Christianity and social science as follows: "The traditions of the college (Yale) are all in favor of the Christian religion, and the public may be assured that the faculty and trustees will never consent to have the atheism of Spencer offered to the students. They can find enough of that without going to college to find books in which Christianity is argued against and ridiculed. We are glad that President Porter stands firm, and we may also add that the resignation of any professor who has sympathies with Herbert Spencer will be a great advantage to the college."

The "Christian Intelligencer" says: "Herbert Spencer's 'Sociology' has been introduced as a text-book. The faculty are divided in regard to the use of such a work. The President, it is said, opposes the study of a book essentially infidel. There should be no difference, no discussion among honest

men upon such a matter. Yale College has been endowed by the gifts of Christian men almost exclusively. To use the foundation they have established for the propagation of skepticism is a breach of trust and is no better than burglary or forgery."

The "Christian at Work" remarks: "It might be of little moment if his text-book were a treatise on pure mathematics or chemistry. But it is otherwise upon such a subject as sociology. That concerns the relation of man to the state, and *vice versa;* it treats of the moralities, and of laws designed to conserve the Sabbath and enforce morality, and of the claims of religion. To all such laws Mr. Spencer is avowedly hostile. . . . Put the youth under the dominion of Spencer's social system, and they will deny the right of the state to enforce a day of rest, or make laws for any other purpose than the bare protection of life and property. Under Spencer's system all other laws would be done away with, and we should have a condition of affairs in which one right alone would be recognized—the right of every one to do as one pleased. . . . We trust the accomplished Professor will himself see the wisdom of deferring to a very proper feeling which we believe unmistakably exists on the part of the Christian public, that nothing should be allowed, however otherwise excellent in itself, which will in the slightest degree unsettle the minds of the young by giving them a bias toward a pernicious, dangerous sociology, which seeks to eliminate public education from the state, and rejects the moral element in legislation save as required for the protection of life and property."

The "Independent" says of the "Study of Sociology": "Theologically it is probably the most objectionable book Spencer has written, making no secret of its contempt for believers in the Christian religion, who are told that they must lay aside their faith if they wish to study sociology. There is enough of this intolerance to make the book decidedly offensive. We are not surprised that complaint was made against the book, although we believe that no pupil of Professor Sumner will accuse him of any lack of faithfulness in pointing out the weak or misleading passages in any author whose text-book he uses. We presume that, before another class has occasion to pursue the study, the works to which this was an introduction, or some better book, will be ready for use, and will replace, with its collections of facts, the offensive philosophizings of the 'Study of Sociology.'"

These extracts are fairly representative of the ideas and the spirit of the religious press of this country. Passing by the various misrepresentations with which they bristle, what is their common upshot? That in its treatment of social science Yale College is bound to take into account, first of all, its theological character as a Christian institution. We say, on the contrary, that the first duty of Yale College, as a seat of liberal learning, is to truth, which is to be cordially welcomed from all sources. It is bound to recognize, first of all, that knowledge is progressive, and to teach it in its most developed and perfected forms. It is not at liberty to disregard the lessons of experience. There was a time when the great universities of Europe were called upon to resist the progress of astronomy, in the name of Christianity. Later, they were again called upon to resist the progress of geology, in the name of Christianity. And now our colleges are called upon to resist the progress of sociology, in the name of Christianity. The demand, futile in the former cases, is now ridiculous. It is an anachronism, and serves only as a register of the survival of bigotry. The mortifying fact is, that we in this country are behind the age in liberty of thought as a guiding principle in higher education. The Reverend Chan-

cellor of the University of New York is reported to have declared that, if the works of Herbert Spencer should be introduced into the institution over which he presides, he would resign his position. Yet these works are introduced and freely used in the English universities. Alike in England, Scotland, and Ireland, students are required to be acquainted with the contents of the "Psychology"; and in some of the universities Spencer's philosophical treatises are used as text-books. Oxford led the way a dozen years ago with the "Biology" as well as the "Psychology," and even went so far as to allow Spencer's works to be given as prizes. In France, the state authorities, who superintend educational affairs, have formally adopted Spencer's works to be introduced into the libraries of the lyceums and colleges throughout the country, and have also made them available for prizes. And all this without any such foolish noise and fanatic splutter as has followed a similar attempt in one of our own colleges.

Something has, however, happened in France equally funny and instructive, which it is proper to mention, especially as it may serve as a hint for compromise on this side. The question is, When an author can not be answered, what is to be done? The tactics of the Chancellor above referred to is to run; but there remains the alternative of expurgation. If there are things that can not be replied to, and which will "pervert the young mind," cut them out. Now, the French have very little trouble with Spencer's treatment of religious subjects, but his irreverence for the ancient classics greatly troubles them. It might be thought a good method to point out his errors to students, but that plan does not meet with favor. And so the Minister of Public Instruction in France has arranged to prepare an edition of Spencer's "Education" which the Government may approve, and in which the part dealing with science and classics is omitted.

Now, why not have an edition of "The Study of Sociology" with the part on the "theological bias" left out? The "Independent" is confidently looking for a new text-book which Professor Sumner can use without theological objection; but why not adopt the French dodge, and protect the students as effectually as may be by dropping out of the existing volume all reference to the influence of religious prejudices in hindering the scientific investigation of social phenomena?

MISUSE OF THE "SCIENCE PRIMERS"

To the excellence of the well-known series of "Science Primers," of which there are now a dozen, we have uniformly testified. They are written by the ablest scientific men of England, who are masters of the topics upon which they write, and they have been prepared under the eminent editorial supervision of Professors Huxley, Roscoe, and Stewart. They have made a very favorable impression upon the public, and met with a success that was sufficiently assured at the outset. A million of the books, it is said, have been called for in England, and they have had a large sale in this country. Professor Huxley engaged to write an introductory primer to the series, which has just appeared, and the public is informed that sixteen thousand copies of it were ordered in advance, of the London publisher. Authors and booksellers are to be alike congratulated upon so brilliant a result.

The secret of this success is undoubtedly to be found in the perfect adaptation of the books to the existing conditions of education. They may be employed in schools without giving the slightest trouble, and are certain to be favorites with teachers who can use them with a minimum of intellectual exertion. They are all so plainly writ-

ten that there is no mistaking the writer's meaning; there are no perplexing problems to be solved; the pupils can learn the short lessons with ease, and the recitations should go on with the utmost smoothness and facility. Yet this perfect conformity of the books to old established school habits, while it has secured their immense success, raises serious questions as to their adaptation to the improved methods of study which are now demanded in early scientific education.

From this point of view we think the title of the series misleading, and that as a consequence the books are liable to be put to a wrong use. The term *primer* suggests the lowest grade of elementary school-books—first books for primary classes, or for children beginning to study. The "Science Primers" are obviously unsuited for this purpose. We should say that the distinguished gentlemen who prepared them, and who are all of them occupied in the absorbing work of scientific research in their respective departments, have not given due attention to that very important matter in early education—the minds of children. This is, in fact, a science by itself of great interest and no little complication, and for the most part quite alien to the special pursuits of these authors. A man may be deep in physics and profound in astronomy, and yet know very little of the mechanism, growth, and various conditions of the unfolding faculties of the child. It matters nothing how clear, simple, and accurate is the text of a primer if it is not skillfully suited to the early stages of mental activity; and this is where the "Science Primers" fail as books for beginners.

It is clear that children can not at first grasp generalizations; and to begin by giving them general principles, and making them learn lessons embodying the results and outcome of scientific thought, is a fundamental educational mistake. They should begin with the simple, the concrete, the familiar, and be very gradually and very slowly led on to combinations of ideas and the perception of simple relations; and only in the higher stages of mental growth should they be tasked with those highest products of science—system, exactness, and abstraction. Knowledge may be put into a child's mind wrong-end foremost, so to speak, and so as to disturb and paralyze its faculties, rather than to favor their natural and healthy growth. The first step in the scientific education of children ought not to be an abrupt transition from their intercourse with the natural objects around them to lesson-learning from books; it should be simply to direct and guide them in making observations. The process should be continuous with their unguided and spontaneous activities, and stimulated by the cultivation of curiosity. Play may run into simple experiments under such careful management as not to create weariness or distaste for this kind of effort.

The "Science Primers" do not sufficiently conform to this method to make them suitable books for beginners. They in fact belong to the advanced, if not the adult, stage of mental development. In the first two books that were published, the "Primer of Physics" and the "Primer of Chemistry," there is a common preface, in which it is said that "the object of the authors has been to state the fundamental principles of their respective sciences in a manner suited to the pupils of an early age. They feel that the thing to be aimed at is not so much to give information as to endeavor to discipline the mind in a way that has not hitherto been customary, by bringing it into immediate contact with Nature herself. For this purpose a series of simple experiments has been devised, leading up to the chief truths of each science. These experiments must be performed by the teacher in regular order before the class." This is all that is said re-

garding the adoption and educational use of these books, and it is open to grave criticism.

In the first place, the *fundamental principles* of the sciences are not "suited to pupils of an early age," and can not be made so by any manner of presentation. The immature mind can not apprehend them, and, though the language in which they are embodied may be learned by heart, there will be no real understanding of the truths conveyed, and the sole "discipline" that can be gained will be that of loading the memory with undigested and unassimilated statements. The mature mind of the race has been long and painfully occupied in working its way to the "fundamental principles" of science; and to pour these into the minds of "pupils of an early age" is not a wise or enlightened practice. Undoubtedly the true method is to bring the young mind "into immediate contact with Nature herself"; or rather to *keep* it there, as this is where the educator at first finds it. But what is "immediate contact with Nature" in this case, but for the pupil to occupy himself with the objects of Nature—to make his own observations, to make his own experiments, to start his own questions, solve his own difficulties, and do his own thinking? All this would be at first rudimentary and crude, and the pupil will not get at "fundamental principles," but he will cultivate his faculties in the only way they can be properly cultivated, by self-exertion. The Science Primers fail for beginners by making no provision for this kind of activity. They are to be told in the old way—they are to have things shown, and explained, and made clear, and everything done for them. "The experiments must be performed by the teacher in regular order before the class." This is the ancient college way of imparting instruction; but even the colleges are departing from it as an intellectual failure, and are establishing physical and chemical laboratories in which the students can be really brought "into immediate contact with Nature herself." Listening to lectures, witnessing experiments, and reciting from text-books, is not that "immediate contact with Nature herself" which rational education now demands. And what is true of the Primers of Chemistry and Physics in this series is equally true of the Primers of Geology, Botany, Astronomy, Logic, and Political Economy. They are all lesson-books of fundamental principles, clear and admirable as expositions, but all of them as much second-hand book-knowledge as the "Primers of History."

It was hoped that Professor Huxley, as chief editor of this series, and writer of the Introduction to it, would have taken up the question of primary scientific education, at least sufficiently to explain and limit the school use of these little books. But he considers other questions, as we show elsewhere in the notice of his volume; and this is the more disappointing, as Professor Huxley has ever been a strenuous advocate of direct first-hand knowledge in science. He long ago declared that "mere book-knowledge in physical science is a sham and a delusion"; and in his last admirable work on the "Study of Zoölogy" he enjoins that the book be read "crayfish in hand"; but is not this principle of equal if not greater importance when it is proposed to deal with "pupils of an early age"?

There is one book, however, introduced into the American edition of the series, which is not liable to the objections here indicated. This is the "Inventional Geometry" of Mr. W. G. Spencer. It is not a child's book, but it adopts the right method. It may be taken up by boys and girls twelve or fifteen years old, and it will do more to cultivate and strengthen their original powers of thought, more to give them clear ideas and mental self-reliance, than all the other Primers of the series put together. But, as it implies some mental effort to gain the power that can only come from exercise, it is not so *easy* as

the other books, and will, therefore, not be a favorite with teachers in schools, and can hardly be expected to have the remarkable success of the other Primers.

LITERARY NOTICES.

CHEMICAL EXERCISES IN QUALITATIVE ANALYSIS. For Ordinary Schools. By GEORGE W. RAINS, M. D., Professor of Chemistry in the University of Georgia. New York: D. Appleton & Co. Pp. 59. Price, 50 cents.

UNDER this modest title, and within very moderate limits, Professor Rains has made a very considerable contribution to sound scientific education. He has had much experience in introducing boys into chemistry, and the course of exercises here worked out he has long verified in practice. His object is to bring the minds of pupils into immediate contact with Nature, and so he puts them at work, at the outset, to find out by trial the chemical properties of substances. His little book provides for no recitations, but for elementary chemical work. The learner is not told; he finds out the properties and reactions of bodies by testing them and by experiment. His progress consists in solving problems, and making what are to him a course of new discoveries. The book is based upon the idea that mere book-knowledge in chemistry is a sham and an imposture.

To facilitate the mode of study adopted, Professor Rains has devised an ingenious and most convenient portable laboratory, to which his manual is adapted, and which will be a great help to students, whether working alone or in school-classes under a teacher. We will give a drawing next month of this useful contrivance, and describe Professor Rains's method more fully.

HENRY'S CONTRIBUTION TO THE ELECTRO-MAGNETIC TELEGRAPH. With an Account of the Origin and Development of Professor Morse's Invention. By WILLIAM B. TAYLOR. Reprinted from the Smithsonian Report for 1878. Washington: Government Printing-Office. 1879.

THE name of Professor Henry is not among those who are associated in the popular mind with the electric telegraph, and yet without his discoveries the electro-magnetic telegraph of to-day could not exist. Though, in making his electric investigations, he was not working with the aim to construct a telegraph, he yet clearly perceived the bearing of his results upon such a system of communication. The telegraph has been a growth to which many minds contributed, and it is desirable that the labors of each of the contributors should be placed in such relations as to show their comparative value. This Professor Taylor has done in the above pamphlet, in which the remarkable investigations of Professor Henry receive a recognition that their importance deserves. Professor Taylor reviews the attempts to operate a telegraph by frictional electricity, then by galvanism, by galvano-magnetism, and finally by means of the electro-magnet. Professor Taylor thus states the contribution of Professor Henry to the solution of the problem: He has, he says, "the preëminent claim to popular gratitude of having first practically worked out the differing functions of two entirely different kinds of electro-magnet: the one surrounded with numerous coils of no great length, designated by him the 'quantity' magnet, the other surrounded with a continuous coil of very great length, designated by him the 'intensity' magnet. The former and more powerful system, least affected by an 'intensity' battery of many pairs, was shown to be most responsive to a single galvanic element: the latter and feebler system, least influenced by a single pair, was shown to be most excited by a battery of numerous elements; but at the same time was shown to have the singular capability (never before suspected nor imagined) of subtile excitation from a distant source. Here for the first time is experimentally established the important principle that there must be a proportion between the aggregate internal resistance of the battery and the whole external resistance of the conjunctive wire or conducting circuit; with the very important practical consequence that, by combining with an 'intensity' magnet of a single extended fine coil an 'intensity' battery of many small pairs, its electro-motive force enables a very long conductor to be employed without sensible diminution of the effect." These investigations of Henry were made from 1829 to 1831. They made the magnetic telegraph, which

the English physicist, Barlow, noticing the rapid diminution in the intensity of the current, had some years before declared impracticable, possible. All later inventors and investigators in telegraphy have had to build upon these investigations. Professor Taylor, in reviewing the work of Morse, points out that he was greatly delayed in his work and committed many errors from ignorance of the existing state of electrical knowledge, and especially because of his ignorance of the labors of Professor Henry. He further points out that the work for which Morse gets credit is, in all its more important features, the work of another man—Alfred Vail, who, with Dr. Gale, was associated with Morse in perfecting the invention. Professor Taylor states that the Morse alphabet and the instrument that was found in practice to work it were both the sole invention of Mr. Vail. The pamphlet will be found an interesting review of this important invention, containing much hitherto unpublished, and giving such recognition of the labors of those contributing to it as their importance deserves. Professor Taylor was for many years connected with the Patent Office, and has therefore had excellent opportunities of informing himself on the subject.

HISTORY OF POLITICAL ECONOMY IN EUROPE. By JÉRÔME-ADOLPHE BLANQUI. Translated from the fourth French edition, by EMILY J. LEONARD. With a Preface by DAVID A. WELLS. New York: G. P. Putnam's Sons. 1880. Pp. 562. Price, $3.50.

THIS is the first appearance in English of the celebrated work of the French economist Blanqui. It is somewhat remarkable that a translation has not before been made, as there is no English work covering the same ground, and as M. Blanqui has succeeded in putting in a moderate compass a large amount of information concerning economic theory and practice, and putting it, moreover, in a way that will prove very attractive to the general reader. Though it is more than forty years since the book was first published, it has lost little or none of its interest for the present, and its translator has conferred a favor upon the public by her excellent rendering of the original. M. Blanqui was the pupil of J. B. Say, and, on the death of that economist in 1833, he succeeded him in the professorship of Political Economy in the Conservatory of Arts and Trades. In his discussion of social and economic questions, the humanitarian element is predominant, and the great value of political economy to him was that it consisted of a body of most beneficent truths which held out the promise and pointed the way to an increasing betterment of the condition of all classes. He had, therefore, a warm interest in all questions concerning the improvement of the industrial classes, and regarded with sympathy the various schemes, rife in his time, for furthering their welfare. With great admiration for the school of English economists, and according to them the honor of placing the science upon a true foundation, he yet protested that their formulas were too rigid, and that they had not taken account of the grain of truth that, along with many vagaries, was to be found in the doctrines of various social sects.

In his view, political economy did not begin when men first carefully studied the phenomena of wealth, and endeavored to elaborate a body of doctrine, but it began much earlier. Men became political economists when they began to exchange the products of their labor, and when they commenced to exercise foresight in providing for their material needs. Since then economic phenomena, as well as the theories held concerning them, have slowly advanced—the one in complexity and variety, the other in a more perfect comprehension of the relations of the facts. M. Blanqui therefore begins his work with a consideration of the political economy of the Greeks and Romans, and traces it onward through the middle ages to the time at which he wrote. In this survey he notices the importance attached by the Greeks to financial matters, the contempt of the Romans for labor and commerce, the influence of Christianity, which he says changed the basis of civilization from slavery to freedom, the change impressed on European life by the influx of barbarians, the rise of the feudal system, and the influence of the Crusades in giving an impetus to commerce. In considering the rise of credit and the institution of banks, he points out the value of the services of the Jews, to whom finance owes so much.

Modern commerce properly begins with the rise of the Italian commercial cities, and thence onward it moves steadily if slowly. Its theory is the mercantile system. Nations only grow rich by despoiling each other, and money is alone riches. This theory, once universal, has not even yet disappeared. It has survived the clearest demonstrations of its falsity, and influences to-day much of the speculation and legislation upon economical matters. The first important school to combat it, and to lead the way to a true theory of wealth, was that of the *Economists*, which arose in France just after the disastrous failure of Law's scheme. Quesnay was one of its founders and most distinguished representatives. It found prepared for it a soil in which it readily took root and flourished. Law's failure had produced an entire revulsion in French sentiment. "People," says M. Blanqui, "had for some time deemed money to be wealth in an especial sense; . . . there were henceforth no true riches but land." The *Economists* came preaching this doctrine. To them agriculture was the only productive occupation. "Manufacturers, traders, workmen, were all paid clerks of agriculture, which was the sovereign creator and dispenser of all wealth." Landed proprietors were rightly preëminent over all other classes. They reaped all wealth; they should, therefore, pay all taxes. Hence the *Economists* would have but one tax—that upon land. And the same reasoning led them to entire freedom of trade. Able men rallied to the support of the new views, and there gradually grew up a body of statesmen imbued with them, one of whom, Turgot, was to attempt to carry their formulas into practice.

The *Economists* were mistaken. They failed to see that wealth can be created by labor; they were blinded by their doctrine of the importance of land, but they have rendered great service. "Their books are forgotten; but their doctrines have germinated like a good seed, and the precepts which they taught have made the circuit of the world, freed the industrial arts, restored agriculture, and prepared the way for commercial liberty." It was reserved for Adam Smith to see clearly what the *Economists* saw dimly, to correct their errors by a true analysis of the phenomena of wealth, and to place economics on an enduring foundation. He restored to labor the position of a creator of wealth denied it by the *Economists*, and he first pointed out clearly the results of the division of labor. He placed commercial liberty upon an impregnable basis, and showed how private interest freed from restrictions works for the best welfare of the individual and society. Great as was his genius, "Adam Smith did not, however, have the honor of creating political economy at a single stroke"; but he laid the foundation upon which his successors securely built. The *Economists* had given to land too prominent a place; he gave it to labor. This his followers corrected: they adjusted the parts, recognized the place of capital, and developed the science symmetrically. But they all failed to recognize sufficiently the welfare of the worker. They all regarded him too exclusively in the light of an economic machine for the production of wealth. This error the economists of the French school have corrected. They have insisted that the value of increase of wealth is to be unceasingly judged by what it brings to the workers, and they withhold their admiration if the thing it brings be not good: "We are to-day obliged to seek a regulator, and to put a curb on those gigantic instruments of production which feed and which starve men, which clothe and which despoil them, which relieve and which crush them. The question is no longer, as in the time of Smith, exclusively that of accelerating production: the latter must henceforth be governed and restricted within wise limits. The question is no longer of absolute wealth, but of relative wealth; humanity demands that masses of men who will not profit thereby be no longer sacrificed to the progress of public opulence. Thus decree the eternal laws of justice and morality, too long disregarded in the social distribution of the profits and the labors; and we will no longer consent to give the name of wealth save to the sum of the national product equitably distributed between all the producers. Such is the French school of political economy to which we profess to belong, and its ideas will make the circuit of the world."

The above will, perhaps, give some idea of the general spirit and drift of M. Blan-

qui's work in viewing social questions, but no one at all interested in such questions will fail to read one of the most fascinating economic works ever published.

A PRACTICAL TREATISE ON NERVOUS EXHAUSTION; ITS SYMPTOMS, NATURE, SEQUENCES, TREATMENT. By GEORGE M. BEARD, A. M., M. D. New York: William Wood & Co. Pp. 198.

DR. BEARD'S work deals not only with a very important subject to which he has paid long professional attention, but to a subject of prominent and painful interest in this country. Nervous exhaustion, or, as he names it, *Neurasthenia*, he declares to be at once the most frequent, the most interesting, and most neglected disease of modern times; while the family of disorders that have been hitherto grouped together under the name of "general debility," "nervous prostration," "nervous debility," "spinal weakness," "spinal irritation," etc., are of comparatively recent development and abound especially in the Northern and Eastern parts of the United States. The author thus states his purpose in the preparation of the book: "To describe with thoroughness if not exhaustively the symptoms of neurasthenia—those hitherto assigned to the other affections or regarded as special and distinct diseases themselves; to show their relation and interdependence; to distinguish them from the oftentimes closely resembling symptoms of organic disease on the one hand, and the symptoms of hysteria and hypochondria on the other hand; to unify and harmonize the complex developments and manifestations of this malady; to indicate its pathology and *rationale*, and trace out in detail its prognosis, sequences, treatment, and hygiene—this is the task I have undertaken in the present volume."

Dr. Beard affirms that there has been a very important progress in the treatment of these affections during the last ten years. "In no department of therapeutics has there been even in this most active age so rapid and successful advance as in the management of nervous exhaustion, and the diseases that result from and are related to it; and hence a subject, the interest of which was originally scientific and philosophic, is now of direct practical and personal concern not only to specialists in the diseases of the nervous system, but to practitioners and to sufferers everywhere."

As the work is chiefly practical and designed for the use of the medical profession in treating the disease as it is found, the question of the causes which lead to it is not taken up. This is a very important branch of the subject, which requires to be itself separately and fully dealt with. Dr. Beard accordingly has in preparation and nearly completed a work on American nervousness, intended to be supplementary to the present treatise, which will discuss both the causes and the consequences of the rise and increase of neurasthenia, and the general nerve sensitiveness which is a kindred phenomenon in this artificial and excitable age. The author remarks that a philosophic and thorough analysis of American nervousness must be a contribution to sociology involving many problems of race, climate, institutions, and social customs.

SCIENCE PRIMERS: INTRODUCTORY. By Professor T. H. HUXLEY. New York: D. Appleton & Co. 1880. Pp. 94. Price, 45 cents.

THE appearance of this little volume has been waited for with eager interest and much impatience, owing to the popularity of the science series, to which it is a stepping-stone, and to the celebrity of its author. Much was expected, and the general expectations will not be disappointed. In the happy selection of its subjects, in the felicity of its illustrations, in the admirable clearness and simplicity of its style, and in the instructiveness of the lessons it inculcates, Professor Huxley's Primer is quite unrivaled, and it will be read by thousands with equal pleasure and advantage. It aims to convey a general idea of the nature and importance of scientific knowledge, to explain science as a method of thinking, to show its practical uses, and to exemplify its systematic bearings and various aspects by means of the most familiar objects. The first division of twenty pages, under the head of "Nature and Science," treats of Causes and Effects, the Properties and Powers of Bodies, what is meant by the Order of Nature and the Laws of Nature, and how scientific knowledge is obtained. The second division is devoted to "Material Objects,"

and sixty pages are given to Mineral Bodies. Water is chosen as a representative natural object, and its remarkable properties are explained step by step, so as to bring out the fundamental physical principles involved in the three states of matter. Ten pages are then given to the properties of Living Bodies, and the Primer closes with a few observations on immaterial objects.

We refer elsewhere to the series of works to which this book belongs, with a view of guarding against their misemployment in schools.

HEALTH AND HEALTH RESORTS. By JOHN WILSON, M. D. Philadelphia: Porter & Coates.

DR. WILSON is of the opinion that many erroneous notions prevail among the Americans as to the value of health resorts, especially those of foreign countries, and he has therefore in this work undertaken to state the value of such places and the conditions that must be fulfilled as to diet, treatment, etc., in order to obtain their benefits. After a short consideration of health and disease, he considers the general principles of regimen for invalids at health-stations, and the therapeutical action of mineral waters, their use and abuse, and the value of baths. He also considers the best winter-stations for consumptives and a number of the foreign mineral springs. Dr. Wilson insists that it is not necessary to go away from this country to get all the advantages of foreign springs, as there is scarcely one of these that has not its counterpart in this country.

MEMORANDUM IN REGARD TO INSTRUCTION IN THE MECHANIC ARTS. By EDWARD ATKINSON. Prepared at the Request of the Committee on Prisons of the Massachusetts Legislature.

IN this memorandum Mr. Atkinson urges the adoption of such a course of instruction with actual practice in workshops, in the reformatory institutions of the State, as has been carried on for some years in the Massachusetts Institute of Technology. The success of this system has been so gratifying at this institute that Mr. Atkinson believes it can not but be of great value in prisons and reformatories. He submits a plan of a workshop to accommodate four hundred pupils, and arranged to give instruction in carpentry, blacksmithing, foundry-work, vise-work, brazing, wood- and metal-working and finishing. The only objection Mr. Atkinson finds to his plan is in the fact that graduates of such reformatories will be much better qualified to earn a living than most of the graduates of the common, and some of the graduates of the higher, institutions of learning.

THE COTTON-WORM. By CHARLES V. RILEY, M. A., Ph. D. Washington: Government Printing-Office. 1880.

THIS is the third bulletin issued by the United States Entomological Commission, and is devoted to a summary of the natural history of the cotton-worm, with an account of its enemies and the best means of controlling it. Illustrations are given of the worm and its enemies, as well as of the various machines designed to be used in exterminating it. Much valuable information will be found in it of service to the planter, both as to the peculiarities of the worm, and on the best means of protection. The bulletin is sent to those desiring it, upon application to Washington.

A SUBJECT-INDEX TO THE PUBLICATIONS OF THE UNITED STATES NAVAL OBSERVATORY FROM 1845 TO 1875. By EDWARD S. HOLDEN. Washington: Government Printing-Office. 1879.

PROFESSOR HOLDEN states that the twenty-two volumes issued from this observatory from 1845 to 1875 contain, on the average, five hundred pages each of valuable observations and discussions, which it is desirable should be easily accessible. He has, therefore, undertaken this very excellent index. It is in the form of a quarto, of seventy-two pages, in paper binding.

REPORT ON THE LANDS OF THE ARID REGIONS OF THE UNITED STATES. With Maps. By J. W. POWELL. Second edition. Washington: Government Printing-Office. 1879.

IN the first three chapters of this volume Major Powell treats of the physical characteristics of the arid regions of the United States, and the rainfall of the Western portions of the country. Mr. G. R. Gilbert has four chapters on the water-supply, on irri-

gable lands, and on the physical features of the lands of Utah. There is also a paper by Captain C. E. Dutton on the irrigable lands of the valley of the Frazer River; and one by Professor A. H. Thompson on the irrigable lands of that portion of Utah drained by the Colorado River and its tributaries. The concluding chapter of the volume, by Willis Drummond, Jr., discusses the question of land grants as aids to internal improvement. The interest and value of the report are shown by the fact that the first edition was soon exhausted, and a second one called for.

STUDIES IN FERMENTATION; THE DISEASES OF BEER; THEIR CAUSES AND THE MEANS OF PREVENTING THEM. By L. PASTEUR, Member of the Institute of France, the Royal Society of London, etc. Translated by Frank Faulkner and D. Constable Robbe. Macmillan & Co. Pp. 418. Price, $6.50.

THERE are but few subjects that would seem less attractive than the scientific investigation of ferments and the processes of fermentation, yet the book before us is alive with interest from beginning to end. This is due to the genius of the author, the scientific importance of his inquiry, the spirited controversies which have recently grown out of the inquiry, and its important practical results. Pasteur is a man remarkably endowed for subtile research. His investigation of the diseases of the silkworm was one of the most difficult, refined, and successful of modern researches. A delicate experimenter, a sharp observer, and a man of keen insight and careful judgment, he has taken the acknowledged lead in investigating the obscure phenomena of microscopic life at the present time. The questions opened are the deepest in modern thought, involving nothing less than the origin of life-forms, and the method of Nature regarding vital phenomena. Pasteur has been in the center of the battle of spontaneous generation, and yet so practical have been his investigations that the brewers are of all men most interested in them. The present work deals with the diseases of beer, and those deteriorations of its processes that are involved in the changes of fermentation; and its leading translator is an author of the "Art of Brewing." The work will be of great interest, therefore, to all engaged in this branch of manufacturing industry, not only by throwing light upon the theory of brewing, but by the solutions it gives of serious practical difficulties hitherto encountered in the brewer's art. Pasteur's elucidations of fermentative action bear also upon the operations of wine-making and vinegar-making, as well as beer-making.

A TEXT-BOOK OF PHYSIOLOGY. By M. FOSTER, M. A., M. D., F. R. S., Prælector in Physiology and Fellow of Trinity College, Cambridge. With Illustrations. Macmillan & Co. Pp. 720. Price, $3.50.

THE writing of his "Physiology" by Dr. Foster was far from being a case of book-making in the ordinary sense. He is a man not only devoted to his subject, but especially and assiduously devoted to its progress, so that the preparation of his text-book was but an incident in his studies, and has, moreover, been a continuous work with him for several years. The third edition, revised and enlarged, is now issued; and it represents, perhaps, better than any other book the recent advance and present condition of physiological science. Dr. Foster is at the head of the new physiological laboratory at Cambridge, England, where the experimental method of physiological inquiry is vigorously pursued; and his text-book is, of course, prepared from that point of view. Under this method, physiological science is slowly acquiring certainty and increasing precision in its conclusions, as no one can fail to see who compares Dr. Foster's text-book with the standard treatises of a few years ago. We agree with Professor Burt Wilder that this is "in some respects the best physiology in the English language." We note that a cheap students' edition of the work is to be issued in a short time.

A FORBIDDEN LAND; VOYAGES TO THE COREA. By ERNEST OPPERT. With 21 Illustrations and Two Charts. New York: G. P. Putnam's Sons. 1880. Pp. 334. Price, $3.

THIS is an interesting account of a little known country in Eastern Asia. The present kingdom of Corea consists of a large peninsula east of the Chinese Empire, extending from 42° north latitude to the

Straits of Corea. The country has always been exclusive in its policy, this exclusion extending in later years even to its near neighbors, China and Japan, so that very little has been known of the physical features of the country or of the habits and character of its people. The country for centuries has been at war with China and Japan, and the scene of fierce internal feuds, and only latterly has it been able to secure itself against its foreign enemies and unite into one kingdom under one ruler. It has been supposed that the Corean Peninsula was settled from China, but this, Mr. Oppert declares, is an utter mistake. The Coreans differ widely in their customs from the Chinese, and do not present the physical appearance to justify such an origin. The upper classes of the Coreans are of a Caucasian type and the lower of a Mongolian one. The country is destitute of native histories, and the people profess to know nothing of their origin, though some of the aristocratic classes have fabulous accounts of it. The author gives much interesting matter concerning the customs, institutions, and natural features of the country, and feels impatient at its seclusion from the trade of the world, and appears to think a forcible opening of it desirable.

UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF COLORADO AND ADJACENT TERRITORIES IN 1876. By F. V. HAYDEN. Washington: Government Printing-Office. 1878.

THIS is the tenth annual report of the survey under the direction of Professor Hayden, and is devoted to the survey completing the work in Colorado and portions of adjacent Territories. The report consists of an account of the work done in the geology, topography, archæology and ethnology, and paleontology and zoölogy of the region. The report has a number of excellent maps, and numerous lithographic plates of the ancient mines examined, and of specimens of the pottery, both ancient and modern, of the natives of the region.

SUNSHINE AND STORM IN THE EAST. By Mrs. BRASSEY. New York: Henry Holt & Co. 1880. Pp. 438. Price, $3.50.

THOSE who enjoyed Mrs. Brassey's account of her "Voyage in the Sunbeam" will welcome her present account of her two visits to Cyprus and Constantinople. The book is in the form of a diary, which is not, it seems to us, a very interesting way of presenting the scenes and incidents of travel. The work is profusely illustrated and handsomely printed on heavy calendered paper. The cover strikes us as somewhat flashy, but is designed, we presume to be artistic.

PUBLICATIONS RECEIVED.

Does Spiritualism transcend Natural Law? By W. G. Stevenson, M. D. 1880. Pp. 25.

Interoceanic Ship-Railway. Remarks of Dr. William F. Channing before Select Committee of the House of Representatives, March 27, 1880. With Exhibits. Pp. 10.

The Education of the Blind. An Address before the Wisconsin Teachers' Association, July 10, 1879. By Mrs. Sarah F. C. Little. Pp. 15.

A Catalogue of the Birds of Indiana, with Keys and Descriptions of the Groups of Greatest Interest to the Horticulturist. By Alembert W. Brayton, B. S., M. D. Indianapolis: Douglass & Carlow. 1880. Pp. 77.

Remarks of Hon. Barton A. Hepburn in Support of the Bill entitled "An Act to regulate the Transportation of Freight by Railroad Corporations." Albany: Weed, Parsons & Co. 1880. Pp. 30.

A Study of some of the Starches. By Mrs. Lou Reed Stowell. Ann Arbor. 1880. Pp. 17.

College Libraries as Aids to Instruction. Circulars of Information of the Bureau of Education. No. 1. 1880. Washington: Government Printing-Office. Pp. 27.

The Unity Pulpit. Boston. Sermons of M. J. Savage. No. 21, "The Struggle and Triumph of Man." No. 22, "Patience." No. 23, "The Nearness of God." No. 24, "Faithfulness." By W. H. Savage. No. 25, Series of Talks about Jesus: I. "Sources of our Knowledge." No. 26, "Channing Unitarianism." No. 27, Talks about Jesus: II. "The Miraculous." No. 28, Talks about Jesus: III. "Birth and Childhood."

On the Removal of Foreign Bodies from the Ear: With Four Cases. By Charles Stedman Bull, M. D. New York. 1880. Pp. 9.

Revised Catalogue of the Birds of Chemung County, New York. By W. H. Gregg, M. D. Elmira. 1880. Pp. 25.

Report of the Director of the Central Park Menagerie. New York: M. B. Brown, Printer. 1880. Pp. 32.

Railway Land Grants of the United States. By E. H. Talbot. Chicago: The Railway Age Publishing Company. 1880. Pp. 66.

Valedictory Address to the Graduating Class of the Woman's Medical College of Pennsylvania. By Frances Emily White, M. D. Philadelphia: Grant, Faires & Rodgers, Printers. 1880. Pp. 16.

The Tongue of the Honey-Bee. By Professor A. J. Cook. Reprint from "The American Naturalist." Illustrated. Pp. 9.

On the Foramina perforating the Posterior Part of the Squamosal Bone of the Mammalia. By E. D. Cope. Pp. 10.

A Review of the Modern Doctrine of Evolution. By E. D. Cope. Reprint from "The American Naturalist." Illustrated. Pp. 21.

Some Thoughts and Facts concerning the

Food of Man. By Dr. E. L. Startevant. From the "Report of the Secretary of Connecticut Board of Agriculture." 1880. Pp. 41.

Muscle-Beating for Healthy and Unhealthy People. By M. Klemm. Illustrated. New York: M. L. Holbrook & Co. 1879. Pp. 56. 30 cents.

The Problems of Insanity. A Paper read before the New York Medico-Legal Society, March 3, 1880. By George M. Beard, M. D. Pp. 24.

Proverbial Treasury. English and Select Foreign Proverbs from Fifty-one Different Ancient and Modern Languages. By Carl Seelbach. New York: Seelbach Bros. 1880. No. I., containing 4,900 Proverbs. 50 cents.

Actual Measures of the Great Pyramid of Egypt, disclosing the Architectural System employed. International Institute for preserving and perfecting Weights and Measures. Toledo Blade Printing Co. 1880. Pp. 19.

Studies from the Biological Laboratory of the Johns Hopkins University. No. 1, Session 1877-'78. No. 2, Session 1878-'79. Edited by H. N. Martin, M. A., D. Sc., Professor of Biology. No. 3, Chesapeake Zoölogical Laboratory. Scientific Results of the Session of 1878. Edited by Professor W. K. Brooks, Associate in Biology. 1879. No. 4, Development of the Oyster. By W. K. Brooks. Baltimore: John Murphy & Co. 1880. $1 each.

Camps and Tramps in the Adirondacks, and Grayling Fishing in Northern Michigan. A Record of Summer Vacations in the Wilderness. By A. J. Northrup. Syracuse, N. Y.: Davis, Bardeen & Co. 1880. Pp. 302. $1.25.

Dwelling-Houses: Their Sanitary Construction and Arrangement. By Professor W. H. Corfield, M. A., M. D. New York: D. Van Nostrand. 1880. Pp. 156. 50 cents.

A Series of Questions in English and American Literature. Prepared by Mary F. Hendrick. Syracuse, N. Y.: Davis, Bardeen & Co. 1880. Pp. 76. 35 cents.

Sea-Air and Sea-Bathing. By John H. Packard, M. D. Philadelphia: Presley Blakiston. 1880. Pp. 124. 50 cents.

Post-Mortem Examinations. By Professor Rudolph Virchow. Translated from the second German edition. By Dr. T. P. Smith. Philadelphia: Presley Blakiston. 1880. Pp. 145. $1.25.

Common Mind-Troubles and the Secret of a Clear Head. By J. Mortimer-Granville, M. D., etc. Edited, with Additions, by an American Physician. Philadelphia: D. G. Brinton. 1880. Pp. 185. $1.

The Hair: Its Growth, Care, Diseases, and Treatment. By C. Henri Leonard, M. A., M. D. Detroit: C. Henri Leonard. 1880. Pp. 316. $2.

Free Land and Free Trade. By Samuel S. Cox. New York: G. P. Putnam's Sons. 1880. Pp. 126. $1.25.

Radical Mechanics of Animal Locomotion. By William P. Wainwright. New York: D. Van Nostrand. 1880. Pp. 294. $1.50.

Silver in its Relation to Industry and Trade. By William Brown. Montreal: Lovell Printing Co. 1880. Pp. 134. 60 cents.

Life: Its True Genesis. By R. W. Wright. New York: G. P. Putnam's Sons. 1880. Pp. 298. $1.50.

Practical Keramics for Students. By C. A. Jannier. New York: Henry Holt & Co. 1880. Pp. 258. $2.50.

A Guide to Modern English History. By William Cory. Part I., 1815 to 1830. New York: Henry Holt & Co. 1880. Pp. 276. $2.

Schiller's Complete Works. Edited, with Careful Revisions and New Translations, by Charles J. Hempel, M. D. In Two Volumes, with Illustrations by the Best German Artists. Philadelphia: G. Kohler. 1879. Cloth, .

POPULAR MISCELLANY.

Climate and Complexion.—Correction.—MESSRS. EDITORS: I notice that in my article on "Climate and Complexion," published in your May number, I have, either in so many words or inferentially, made the statements that a dark pigment reflects the rays of light and heat better, and that it is a greater obstacle to their transmission than a light one. These, of course, as they stand, are quite wrong. What I should have said is, that a cuticle containing a dark pigment is less permeable by heat and light, because it is thicker and more opaque. For some reason, which I do not undertake to explain, the coloring matter of the skin, when abundant, is darker than when scanty. Hence, a cuticle containing a dark pigment is less transparent. And because abundance and consequent blackness of the pigment imply thickness of the cuticle, a dark cuticle does not transmit heat so readily as a light one.

J. M. BUCHAN.

BARRIE, ONTARIO, CANADA, *May* 3, 1880.

Summer Schools of Natural History.—We received, too late for insertion in our May number, the announcement of this summer's session of the Chesapeake Zoölogical Laboratory, which was to open April 22d at Beaufort, North Carolina, and continue until the 1st of September, under the direction of W. K. Brooks, Assistant Professor of Zoology and Comparative Anatomy in Johns Hopkins University. The house to be used as a laboratory is near the water, and the equipment includes boats, nets, dredges, aquaria, books, microscopes, and all the necessary appliances for collecting and studying marine animals and plants, and a steam-launch for dredging and surface collecting.

The fifth session of the Summer School of Biology at Salem, Massachusetts, will be held at the museum of the Peabody Academy of Science, Salem, under the direction of Professor Edward S. Morse. Professor George L. Goodale has kindly consented to give six lectures on physiological botany. The other instructors are Mr. John Robinson, cryptogamic botany; Mr. John H. Sears, analytical botany; Professor H. H. Straight, anatomy and physiology of the vertebrates;

Mr. Charles Sedgwick Minot, embryology; Mr. Charles Fish, entomology. Mr. Morse will lecture on the invertebrates. The school will commence July 6th, and continue six weeks. It is designed expressly for teachers.

A Summer School of Biology will be opened at Drury College, Springfield, Missouri, on July 1st, to continue not less than six weeks. The course is designed mainly for teachers; and lectures, laboratory study, and excursions will be the chief means employed for carrying on the work. Mr. E. M. Shepherd, of Drury College, will instruct in the departments of Invertebrate Zoölogy and Cryptogamic Botany; Mr. C. H. Ford, of the State Normal School, is to have charge of Vertebrate Zoölogy and Phænogamic Botany; Mrs. H. C. Milner will give instruction in methods of teaching Elementary Science; and Dr. T. U. Flanner will instruct in Microscopy.

Rearing Silkworms in England.—Mr. Alfred Wailly contributes to the "Journal of the Society of Arts" some valuable notes on silk-producing bombyces which were bred in England during 1878. The *Attacus Yama Mai*, or Japanese oak silkworm, is difficult to rear, since it is in the egg state in the winter. The eggs have to be kept protected from the rain and the rays of the sun, and a special provision of young oak-trees which have been potted and protected from the frost, not forced, is recommended in case they hatch out too soon. The *Attacus Pernyi*, or Chinese oak silkworm, is very easy to rear in the open air, and will feed, like *Yama Mai*, on all species of oak. The young worms of the first brood hatch in June or the beginning of July, when there is an abundance of foliage to feed them. The species is reproduced with great facility. The hatching of the second brood in the fall should be prevented by keeping the cocoons in a cool place. *Attacus cynthia*, or the ailantus-worm, will feed, but not as well as on the ailantus, on the laburnum, lilac, and cherry. *Attacus Atlas* feeds on the apple, plum, peach, barberry, etc., and seems to have been reared with success. *Attacus Selene*, a "magnificent species" from India, was introduced into Europe in 1878. The raising of it is apparently hazardous, for, though there were plenty of ova, and they hatched out well, many of the larvæ died in the last stage. A good account is given of the *Attacus polyphemus* and *Attacus cecropia*, from North America, which thrive well on a variety of plants.

About Beer.—An account of the production and consumption of beer throughout the world is given in the work of Mr. Von der Planitz on "Beer," which we have already noticed. The scientific investigations which have been made on subjects relating to fermentation have led to improvements in the processes of manufacture, and to the establishment of numerous schools or departments of schools in Germany and other countries where these subjects are specially studied. The foundation of a brewers' school in the United States has been talked of since 1871, and was one of the subjects considered at the Brewers' Congress held during the Great Exhibition at Philadelphia in 1876; but it has not yet taken shape. A considerable library of books relating to the practice and science of brewing has been published, and journals devoted to the business and the art are printed in Germany, Austria, Bohemia, France, England, and the United States. A number of scientific and experimental stations and laboratories have been established in Germany, where special researches are still carried on. A consolidation of works for brewing seems to be going on in all countries, so that the steady increase in the production of beer is attended by a decrease in the number of breweries. This feature is, however, common to most contemporary industries. Great Britain leads all other countries in the manufacture of beer, as well as in the production of barley, but returns a smaller production of hops than Germany. Germany is not far behind it, while the United States stands third in the list, and is followed by Austria, Belgium, and France. Belgium produces the largest quantity (149 quarts) per head of the population, and Great Britain (143 quarts) next. Germany (94 quarts) holds the third place by this criterion, and the United States (38 quarts) the sixth, being surpassed by Denmark and the Netherlands. The statistics of single states in Germany and of the Austrian Empire indicate that

the amount of beer produced in those countries has about tripled within the last forty years. The production of Great Britain increased from 7,670,100 barrels in 1830 to 25,336,811 barrels in 1870. It consists chiefly of the ancient amber-colored ale and the modern dark-brown porter. The Belgian beers are the mars, a thin beer; the lambic, a strong and light-colored drink; and the faro, which the retailer himself prepares by mixing the other two kinds. The production of France has more than doubled since 1842. A strong lager-beer and a weaker small-beer are most in favor, and the foreign beers are in common use. The principal consumption is in the north, the people of southern France inclining more to wines. The same is the case in Italy, where a light, highly-fermented beer is produced, and a considerable quantity is imported from Austria; but no beer is used south of Naples. The manufacture and consumption of beer are increasing very rapidly in Russia, and a great deal is imported into that country from Austria and England. In Sweden and Norway nearly every man brews his own beer at home. No lager-beer was made in the United States forty years ago. In 1876 the President of the Brewers' and Maltsters' Association asserted that it was the great national drink which was to drive out whisky, and that there were 2,783 breweries, employing 35,400 hands, and producing 330,600,000 gallons. In all Europe and America 63,631 breweries produce yearly more than 3,480,000,000 gallons of beer.

Dampness and Diphtheria.—The opinion that a close connection exists between diphtheria and dampness of site is confirmed in some English reports recorded by Dr. Woodforde. In an outbreak of diphtheria at Purley in 1878, the cottage in which the earliest cases occurred was much shut in by trees, and, although it was very clean, it was damp and insufficiently ventilated, especially in the sleeping-rooms, it was exposed to the emanations of the cess-pit, and the water was not pure. At Ramsbury, where diphtheria was unusually fatal in 1877 and 1878, the ordinary sanitary defects were not much worse than in other villages, but the sites of many of the cottages were almost level with the river, and damp, with the subsoil water very near the surface. At Clifton-Hampden, where diphtheria had occurred for several years in succession, the ordinary defects of porous cess-pits and polluted water were noted, though not to so great an extent as at other places where there had been no diphtheria, but the village also appeared damp, and a stagnation of air was evidently occasioned by the number of trees adjoining the cottages. Sanitary improvements were instituted, the trees were thinned out, and a gale took away some that had been left, and the disease has not appeared in the place since.

Features of the Central Arabian Desert.—Mr. W. S. Blunt read a paper, last December, before the Royal Geographical Society, on a journey he had undertaken during the preceding winter from Damascus to the Jebel-Shammar, in the region of Nejo in Central Arabia, in which he passed through a country that no European had visited since the journeys of Mr. Palgrave and Colonel Pelley in 1863 and 1864. On his way he traversed the red, sandy desert of the Nefud. Here he observed a strange phenomenon, which he describes as the only feature of the tract. The whole surface of the plain is pitted with deep horseshoe hollows, called by the Arabs *fulj*, which are shown to be permanent in site and conformation by the shrubs and bushes which line their sides, and by the tracks which cross and recross each other in such of them as are frequented by sheep. They are absolutely uniform in shape, differing only in size, and are all set with great regularity toward the same point of the compass. In form they exactly reproduce the print of an unshod horse's hoof, the toe pointing westward and being marked by a steep declivity, while the bottom of the hollow slopes gradually upward to the heel, until it reaches the general level of the plain. The frog of the hoof is roughly represented by a number of shallow watercourses converging to the lowest point, the toe. Solid ground sometimes occurs at the bottom of the deepest of the pits. They vary in depth from twenty to two hundred and twenty feet, and in width from fifty yards to half a mile; the appearance of depth is often enhanced by a

sand-mound at the western edge of the hole. As seen from the tops of the higher rocks, the *fuljes* "run in long, sinuous strings with a main direction generally corresponding with their aspect," which gives them still more the appearance of huge horse-tracks. This desert is provided with a vegetation of its own, and is well clothed in the hollows and most of the plain with shrubs. The plants include three grasses and "two considerable shrubs, almost worthy to be ranked as trees." The *ghatha*, growing sometimes to the height of twelve or fifteen feet, gives a bright, smokeless flame, and makes the purest charcoal in the world. The Bedouin tribes make their summer home here, living on the milk of their camels, and independent of water, and always finding pasture. Among the wild animals are the ostrich, hares, the ibex, the leopard, a marmot, snakes, lizards, hawks, buzzards, the bustard, and one or two smaller birds. A wild cow, or white antelope, related to the African antelopes, is native to the region. Tracks of this animal were seen at least a hundred miles from any place where it could have procured water, confirming the assertion that it never drinks. Of insects, the dragon-fly, beetles, ants, and the common house-fly were noticed. A specimen of the painted lady butterfly, famous for its long flights, was seen sunning itself on the rocks of Aalem. This insect could not have been bred at any nearer point than the hills of Syria, four hundred miles off.

Insect-Powders as Remedies for Flies and the Aphis.—The insect-powders commonly sold are the powdered flowers of different species of Pyrethrum. Of the two principal kinds, which are known as the Persian and the Dalmatian powders, the Dalmatian is the more energetic. The flowers, whether whole or powdered, preserve their activity for a long period. Samples, which have been kept for six months, show no depreciation. They may be used with much effect against house-flies simply by charging the room with the dust. Mr. William Saunders says, in the "Canadian Entomologist," that he has frequently, after having charged the air in his kitchen and dining-room at night, found all the flies lying dead on the floor in the morning. Few will escape when the room is closed for half an hour after using the powder. Mr. Saunders has also applied the powder with excellent success to the destruction of the green aphis in his greenhouses. The pests will fall to the ground when the dust is blown among the plants, and in the course of an hour or two the greater part of them will be found disabled; they seem, however, to be only stupefied, not killed, as the flies are, and must be taken care of. The powder gives a more convenient and pleasant remedy than any other that we have. It is, moreover, safe.

The Damposcope.—Professor Forbes has invented an instrument for detecting fire-damp and determining the quantity of light carburetted hydrogen in the air, which he calls the "damposcope." Its construction is very simple. Over the mouth of a straight brass tube is fixed a tuning-fork; inside the brass tube slides another tube of the same metal, which is moved by a regulating screw, so that the compound tube can be lengthened or shortened at will, and this movement is registered on a dial. To ascertain the amount of fire-damp in the pit, the instrument is taken to the suspected spot, the tuning-fork is set vibrating, and the screw is turned until the maximum sound is emitted. The index is then read off. It appears that the quantity of gas can be determined to within one half per cent.

A New Metallic Compound.—Mr. Granville Cole, Ph. D., recently described before the British Society of Arts a new metallic compound which possesses some remarkable and valuable qualities. Its preparation is based on the principle that the sulphides of metals combined with molten sulphur form a liquid, which, on cooling, becomes a solid homogeneous mass, possessing great tenacity, and having a peculiar dark gray—almost black—color. Nearly all the metallic sulphides will form, with an excess of sulphur, combinations which have the same properties. The combination used by Dr. Cole in illustrating his address was formed of an ore of iron pyrites containing lead and zinc sulphides. It belongs to the class of compounds known as thiates, or sulphur sulphides. The compound has the advantages of a low melting-point, 320° Fahr.,

of expanding on cooling, of resisting atmospheric and climatic influences better than marble or bronze, of superior resistance to acids, alkalies, and water, and of being susceptible of a high polish. A polished surface of the metal has been exposed for six months in all weathers without showing any change, and another specimen suffered but little from a month's soaking in *aqua regia*. By reason of its low melting-point it is easily prepared for the mold, and in consequence of its power of expanding it gives a nearly perfect cast. In the gelatine mold it yields an impression before the form of the mold is destroyed, and then, if the gelatine be allowed to remain on the metal till it is cooled, it remodels itself so as to be ready for the next casting. The compound, which is called Spence's metal, after its discoverer, Mr. J. Berger Spence, is useful for castings of all kinds, is better adapted than lead for the joinings of gas- and water-works, is suitable for vessels in which chemical processes not requiring a high temperature are to be conducted, and may be employed for joining railings to stones, for coating the holds of ships, for forming damp-proof shields in the walls of houses, for hermetically sealing bottles, for covering cloths, for preserving fruit and other articles of consumption, and to take the place of metal-lined boxes. For all these, and many other purposes, its cheapness and its general adaptability give it a great advantage, for its cost is calculated as only about one fourth that of lead.

The Electric Light and Vegetation.—Dr. C. W. Siemens has recently conducted experiments for two months on the influence of the electric light on vegetation. He planted the quick-growing seeds of certain common hardy vegetables in pots, and divided these pots into four groups, of which one was kept in the dark, one was exposed to the influence of the electric light only, one to the influence of daylight, and one to the influence of the electric light and daylight in succession. The electric light was applied for six hours each evening, and the plants were left in darkness during the remainder of the night. The plants that were kept entirely in the dark soon died; those exposed to the electric light only, or to daylight only, throve about equally; and those exposed to both daylight and electric light throve better than either. The experiments showed that the electric light is efficacious in producing chlorophyl in the leaves of plants, and in promoting growth. It also appears from them that an electric light equal to fourteen hundred candles, placed at a distance of a little more than two yards from growing plants, is equal in effect to the average daylight of the English March. Other conclusions, which Dr. Siemens thinks he is justified in drawing from his experiments, are—that plants do not require a daily period of rest, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to the electric light; that the radiation of heat from powerful electric arcs can be made available to counteract the effects of night-frost, and is likely to promote the setting and ripening of fruit in the open air; and that, while under the influence of electric light, plants can sustain increased stove-heat without collapsing. The expense of electro-culture, being dependent on the cost of mechanical energy, may be made very moderate where natural sources of such energy, such as waterfalls, are available. The buds of tulips, placed in the full glow of an electric lamp during the lecture in which Dr. Siemens related his experiments, expanded into full bloom in forty minutes. It is said that in India, where the bamboo throws up its shoots at the beginning of the rains, it rarely does so with vigor before the occurrence of a thunderstorm, and that its growth is more rapid as the thunderstorms are heavier.

A Test for Watches.—The corporation of Yale College have established an horological bureau in connection with the Winchester Observatory, for the purpose of encouraging improvement in watchmaking and pursuing researches in whatever may aid in the construction of refined apparatus for the measurement of time. In connection with this object they have provided apartments and made other arrangements for testing the running qualities, as to regularity, etc., of such timepieces as may be submitted for the purpose. Certificates of performance are given to the watches thus tested according to the standard of excellence they show. The apartments include a room of the ordi-

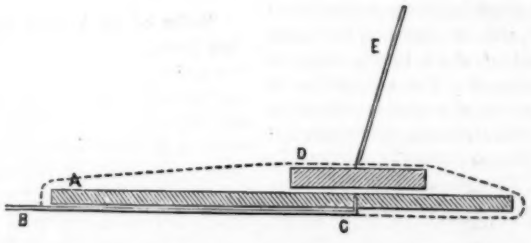
nary temperature (65° to 75°), a cold room (40°), and a hot room (90°), and the watches are tested in the vertical and horizontal positions. Eight classes of certificates are given, corresponding with different combinations of the several tests and their relative duration. In cases where no certificate can be given the movement will be returned to the maker, with a statement of its performance.

Snakes and Snake-Poison.—Professor Huxley, in a lecture on "Snakes," at the London Institution last December, said that no creatures seemed more easily destroyed by man and few less able to defend themselves; yet there were not many animals gifted with so many faculties. The snake can stand up erect, climb as well as any ape, swim like a fish, dart forward, and do all but fly in seizing its prey. The destructiveness of snakes to man is illustrated by the fact that twenty thousand human lives are yearly lost in India by their poison, and it might safely be said that they are a more deadly enemy to our race than any other animals. The speaker pointed out some very curious arrangements in the anatomical mechanism and jawbones, illustrative of the statement that the snake can not properly be said to swallow his prey; he holds on to it rather, gradually working it down its throat in a most leisurely manner, but never letting it go. He requires a very fully developed and effective apparatus of salivary glands for this purpose. The poison-bag of the venomous snakes is nothing but a modification of the salivary glands of the harmless species, the structure of both kinds being in almost all respects not only parallel throughout, but almost identical. As another instance of the close relationship, it was shown that the sharp channel-needle which conveys the poison of the cobra and its congeners is nothing but the development of the tooth which these murderous reptiles possess in common with innocuous snakes. The fact that the salivary gland was the poison-laboratory of the deadly snakes, as well as the known properties of the saliva of dogs or other living creatures affected with rabies, appeared to Professor Huxley to point out the direction in which lies the solution of the difficult problem of the cause of snake-poisoning, and of a possible antidote against it. At present there was no man living who could heal the bite of the cobra, except by cauterization in very fresh cases. A fitting supplement to Professor Huxley's remarks is afforded by facts given in the reports of the Snake-Poison Commission of Calcutta, showing the number of snakes killed, and of deaths by snakes and wild animals in India. In 1875, 270,185, in 1876, 212,371 snakes were killed in all India. The deaths by snakes and wild animals were 21,000 in 1875, 15,946 in 1876. These figures do not give the whole numbers, for the registries are incomplete in the English districts, and no registries are kept in the native states, so that it may be found hereafter that many thousand deaths must be added to complete the catalogue of annual disaster from snakes. The excess of numbers in 1875 is accounted for by the fact that the floods of that year drove the snakes to the high-roads and exposed places. Remedies are said to be known for the poison of all the snakes except the cobra.

Development of the Limbs of Saurians.—Professor O. C. Marsh has noticed some peculiarities in the limbs of the sauranodon, the new saurian described by him in January, 1879, which give it a special interest. Both the anterior and posterior limbs are less specialized than in any other known vertebrate above the fishes. In the fore-paddle, the humerus alone is differentiated. Below this, the bones of the forearm, the carpals, metacarpals, and phalanges are essentially rounded, free disks, implanted in the primitive cartilage. The structure of the posterior limb is substantially the same. The most striking features of the limbs are the presence of three bones next below the humerus and the femur and articulating with them, corresponding apparently with the radius, intermedium, and ulna in the fore-limb, and with the tibia, intermedium, and fibula in the hinder limb, and the fact of six digits. These characters are held to mark a stage of development below that seen in any other air-breathing vertebrate, and only approached by the limb of the icthyosaurus. The intermedium seems, in the process of differentiation, to have been

crowded out of its original position between the marginal bones of the second or epipodial series into the third or mesopodial series. In icthyosaurus, the intermedium is not entirely excluded from the third row; in plesiosaurus and all other reptiles the process is essentially completed. In some amphibians, the bone still separates the lower end of the two specialized bones above it. Sauranodon marks an earlier and most interesting stage in the differentiation, and indicates how the transition was accomplished. Some of the amphibians retain remnants of a sixth digit, and icthyosaurus often presents traces that represent lost digits; but with these exceptions the normal number of five digits is not exceeded in any other air-breathing reptile than sauranodon.

To pierce Glass with the Electric Spark.—In the usual process of piercing glass with the electric spark when the glass is thick, one of the wires has to be inserted in a bed of insulating resin, quite thick, and which has itself to be melted upon the plate of glass. The operation, involving the use of heat, is inconveniently long; and, besides, the trouble of cleaning the glass of the resin has to be gone through after the hole is made. The process described below by M. Fages, architect of the city of Narbonne, is easy of application, and requires only a few minutes for preparation and execution. The apparatus is so simple that any one can construct it for himself, and it may be used for an indefinite number of operations. The cut represents it in vertical section. It consists of—1. A rectangular plate, A, of hardened, black India-rubber, which should be, for a coil giving a spark of four inches, not less than six inches long and four inches wide; 2. A brass wire, B, the bent point of which, C, screwed or pushed into the India-rubber plate, rises even with its top. To use the apparatus, we lay it horizontally on a table, and put the brass thread B in connection with one of the poles of the magnetic coil; then pour some drops of



olive or other oil on the India-rubber plate above the point C, and put upon it the plate of glass D, which is to be pierced, taking care that no bubbles of air are inclosed. The oil causes the insulation of the point C. This done, connect the wire E with the other pole of the coil and produce the spark. It is very easy, by moving the glass along, to make a number of holes as close to each other as may be desired. The only precaution necessary is to have the India-rubber plate large enough—so large that it will not be possible for the spark to jump between the wires by following the routes indicated by the dotted lines.

An Electrical Railway.—Mr. Werner Siemens exhibited an electrical railway at the recent exposition in Berlin, with which he attained a fair degree of success in transmitting electrical power to a distance, and applying it to the movement of carriages. This apparatus consists of a dynamo-electric machine fixed in the station supplying force to a second machine placed on a locomotive-carriage and connected with it by the rails of the track and a third rail which is insulated in the middle of the track. The electrical current is transmitted from the generating machine to the locomotive through the middle rail, and is returned through the wheels and the rails of the track. The carriages to be drawn by the locomotive are all electrically connected with it, so that communication is established through all the wheels. The train exhibited by Mr. Siemens consisted of the locomotive and three carriages with seats for six persons each.

With this train and its eighteen passengers an effective force was gained equivalent to that of two horses. In the interior of the exposition building a force equivalent to that of three horses and a half was gained, and a speed of 7·8 miles an hour. Mr. Siemens, in giving an account of his invention to one of the societies a few months ago, did not seem to have much faith in its practicability, for he said he was afraid that "a great deal of water would run into the Spree before his dream would be realized," but his firm has since submitted to the city of Berlin a proposal for the construction of an elevated railway across a part of that capital, to be operated by his machines. A track is contemplated similar, in its elevation and relations to the street, to the tracks of the elevated railroads in this city. The carriages will be narrow and short, to contain ten sitting-places and four standing-places. The machine to propel them will be placed under the floor of the carriage between the wheels, and a steam-engine with sixty-horse power, which will be employed in the production of the electricity, will be placed at the terminus. A speed of about twenty miles an hour is anticipated. The magistrates of Berlin have appointed a special commission of engineers and architects to examine into and report upon the proposal.

Insects in Libraries.—Dr. H. A. Hagen, of Harvard University, has given in the "Library Journal" some observations on "Insect Pests in Libraries." The principal insects which our libraries have to dread are the larvæ of a beetle (*Anobium*), the same which is obnoxious to old furniture and picture-frames, which has been known for more than one hundred and fifty years, and the white ant. The beetle will eat through the thickest books, making a network of small passages, and, in some places, larger holes for its transformation. The white ants have been known for a long time in southern and western France, but did not appear especially injurious to books till about 1825, when they became very destructive. Some years later they did less damage, and at last disappeared without any apparent reason. These white ants exist in the United States, where instances of their destructiveness to books have been brought to notice in Springfield, Illinois, and in South Carolina. They are present at Cambridge, Massachusetts, in near neighborhood to buildings containing libraries. Mr. J. A. Lintner, of Albany, has noticed cases of cockroaches eating through the coating of the cloth binding of books stored in a basement; and the writer of this note has observed new books similarly injured by the common Croton-bug while they lay in a dry desk-drawer. The best remedy for insect depredations is constant use of the books. There are and must be in all complete libraries books which are used infrequently, and some which are very rarely used; and these afford good hiding-places for the larvæ of the beetle. They may be killed without hurting the books, by putting the books under the glass bell of an air-pump and drawing out the air. After an hour the larvæ will be found to be dead. Constant attention is the only remedy against the white ants.

Relics of an Ancient Race in Eastern New York.—Mr. S. L. Frey describes, in the "American Naturalist," some relics of an ancient race which he has found at a place he does not name in eastern New York. A number of arrow-heads, and a small copper awl, square and of regular shape, which may have been used for a drill, had been found before at the same place. He discovered two tubes bored in cases of steatite, a sea-shell adapted to use as a drinking-vessel, several bone awls, fragments of deer-horn implements, a gouge made of bone, implements of hornstone, beautifully chipped and of perfect proportion, and other articles usual in such places. In another grave, what had apparently been a necklace or head-dress, composed of copper and shell beads, was found. The copper beads had been made of thin sheets of copper rolled into tubes; the shell beads, which were from half an inch to one inch and three quarters in length, and of an average diameter of about half an inch, were made from the columellæ of large sea-shells rubbed and ground smooth, and drilled through their largest diameter. A similar necklace, but partly composed of small sea-shells, was found in another grave. The deepest grave

was four feet deep, and contained one hundred and eighty-nine arrow-heads. It is especially mentioned that in two of the graves the bodies had been buried in an extended position.

A Chinese Hygieopolis.—According to Dr. W. Wykeham Myers, of the British Naval and Consular Service, Dr. Richardson has been anticipated in his "Hygieopolis," or city of health, and a city very like that which he has described as ideal is in existence at Wen-Chow, China. Dr. Myers is not prepared to say that the parallel is perfect, but observes that the similarity is so close as to warrant his alluding even to the high standard set up by Dr. Richardson. All the main and pleasant features of "Hygieopolis" above-ground were found at Wen-Chow, and even the deficiencies in the Chinese city did not prevent Dr. Myers from being surprised at the passing resemblance it presented to the ideal.

Animal Intelligence.—The following, cut from a recent issue of the "Portland Transcript," was sent to us by a valued correspondent, who vouches for its truth: "A friend gives us this dog-story as coming under his own observation: A bull-dog and a Newfoundland came into collision in Federal Street. The Newfoundland took to his heels for safety, and was closely pursued. Seeing that he was likely to be overtaken, he caught up a bit of dirt from the street, and at the critical moment dropped it as if it were something of value he was obliged to give up. The *ruse* succeeded; for the bull-dog stopped to pick up the supposed titbit, and the Newfoundland escaped. The disgust manifested by the vicious brute, when he found how he had been outwitted, is said to have been very comical."

Prehistoric Africa.—Dr. Emil Holub, the Austrian traveler, in a recent lecture before the British Anthropological Institute, on the central South African tribes, mentioned that he had found along the South African coasts clear traces of extinct tribes who, judging from their relics and from other indications, must have been of a very low type. Passing farther into the interior, there were evident relics of quite a different stage of culture, reminding him of the great African empire which the Portuguese marked on their maps as Monomatapa. Among them were workings of ancient mines, some even of gold, and the ruins of a rude kind of cyclopean fortifications. Such evidences, he held, pointed to exterminated tribes, and testified to the antiquity of the savage African rule of warfare, which destroys all the males, and allots the wives and children to the victors as slaves.

Production of Precious Metals in Colorado.—Mr. Frank Fossett, the author of a valuable work on Colorado, reports on the basis of his later observations, that that State has taken an immense stride forward in its mining industries during the past year, and has distanced California in the production of the precious metals. He believes that it will next year surpass Nevada and all other mining regions in the field of gold and silver. Full detailed statements have not yet been received from all quarters, but enough is known to make it sure that the return of the State for 1879 will amount to $18,650,000. The present rate of production is estimated at over $2,000,000 a month, with a prospect of a steady increase hereafter; and the entire product of 1880, it is believed, will be between $25,000,000 and $30,000,000. The product of last year consisted of $14,100,000 in silver, $3,000,000 in gold, $1,450,000 in lead, and $125,000 in copper.

The Carpet-Beetle.—Mr. A. S. Fuller contributes some notes to the "American Entomologist" on the habits of the carpet-beetle, whose larva is commonly called the Buffalo-moth, which may be of help in finding a remedy for the ravages of the insects. The larvæ feed on carpets and woolens, but the fully developed insects feed and pair out of doors, after which the female returns to the carpets to lay her eggs. Mr. Fuller found the beetles last summer feeding on the pollen of spiræas, catching them for several weeks on these plants, but on no others in his garden. As the spiræas are very abundant in all parts of the country, it would be easy to plant a number of them around the house as a bait for the beetles, where, by watching them carefully, the in-

sects may be killed. The small flowering species seem to be preferred by the beetles, and are therefore recommended, as the goat's-beard (*Spiræa aruncus*), sorb-leaved (*S. sorbifolia*), and meadow spiræa (*S. ulmaria*). They are, moreover, desirable plants for their beauty.

NOTES.

PRIOR to the beginning of the eighteenth century opium was imported into China in comparatively small quantities, and mainly used as a remedy in dysentery. The vice of opium-smoking began in the latter half of the seventeenth century, but the drug was then too dear to permit the habit to spread rapidly; at the end of a hundred years, however, it had extended over the whole empire. The first edict against the practice was issued in 1796, and since then there have been innumerable prohibitory enactments, but all powerless to arrest the evil, which is now greater than ever before, and increasing in an alarming ratio.

M. FAUTRAT has been convinced, by his studies of the influence of forests upon the moist currents that pass over them, that pines and other needle-leaved trees have a strong attraction for the vapor of water. He believes that the resinous trees transpire twice as much as other trees; and has also observed that when they are exposed to moist air they absorb vastly more water than the latter.

THE deaths have been recently announced of two of the most prominent entomologists of Continental Europe. Ernest August Helmuth von Kiesenwetter was a member of the Saxon Privy Council, an accomplished and conscientious worker in the science, a considerable traveler, and a close observer. He was chiefly a coleopterist, but attended more or less to all orders of insects, while limiting his studies chiefly to those of Europe. S. C. Snellen van Vallenhoven, of Holland, was best known by his works on the insects of Holland, and his "Entomological Fauna of the East Indies." He also produced a work, which is still incomplete, on the "Ichneumonidæ of Northwestern Europe." All of his works were illustrated by beautiful and faithful drawings from his own pencil.

MR. GRAMME is building for an establishment at Noisiel, France, a machine for transmitting electrical force to a distance, with which he expects to gain a normal power equivalent to that of ten horses, and under special conditions a power of sixteen horses.

THE death is announced of Dr. Wilibald Artus, Professor of Philosophy at Jena, on February 7th last, aged seventy years. Also of Dr. Franz Xaver von Hlubek, Professor of Agriculture at the Graz Joanneum, on February 10th, aged seventy-eight years. In the third week of February also died Herr Adolf Müller, one of the directors of the well-known Geographical Institute of Justus Perthes at Gotha.

CAREFUL investigation into the cause of the fire which broke out on the steamship Mosel revealed the fact that it originated spontaneously in silk goods which constituted a part of her cargo. Chemical examination showed that for every part of silk fiber "0·75 part of oxide of iron and 2·50 parts of coloring matter—consisting of fatty oils, organic and earthy matters—had been used to give weight and body to the silk."

FROM data obtained by a series of elaborate experimental researches, Professor F. Rosetti estimates the effective temperature of the sun at 9,965° centigrade, taking into consideration the absorption produced by the terrestrial atmosphere. But, estimating also the absorption of the solar atmosphere, and calculating the thermal effect of the sun if it had no atmosphere, the solar temperature would be 20,380·7° centigrade.

GENERAL WILLIAM MUNRO, of the British army, and a learned botanist eminent for his thorough and comprehensive knowledge of the grasses, died at his residence near Taunton, England, on the 29th of January, aged sixty-four years.

THE French Government has taken action with a view to the protection of the domestic birds of the country, prohibiting in the several departments the pursuit of other than birds of passage, and those only under certain limitations.

RECENT official reports show that the adulteration of food and drugs has largely decreased in Great Britain under the operation of the legislation against it. In 1856, when the "Lancet" commission made a report of its inquiries on the subject, more than half the samples analyzed were found to be adulterated. The first analysis under the act of 1875 was made in 1877, when it was shown that of the samples subjected to analysis the proportion of adulterated ones had fallen to 19·2 per cent. In 1878 the proportion fell to 17·2 per cent. If spirits be excluded from the calculation, the percentage of adulteration would be represented by 15·5 in 1877, from which it fell to 13·7 in 1878.

THE French papers chronicle the death, at the age of eighty-two, of Dr. Boisdoval, a distinguished horticulturist, and author of a valuable work on the insects which affect garden-plants.

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